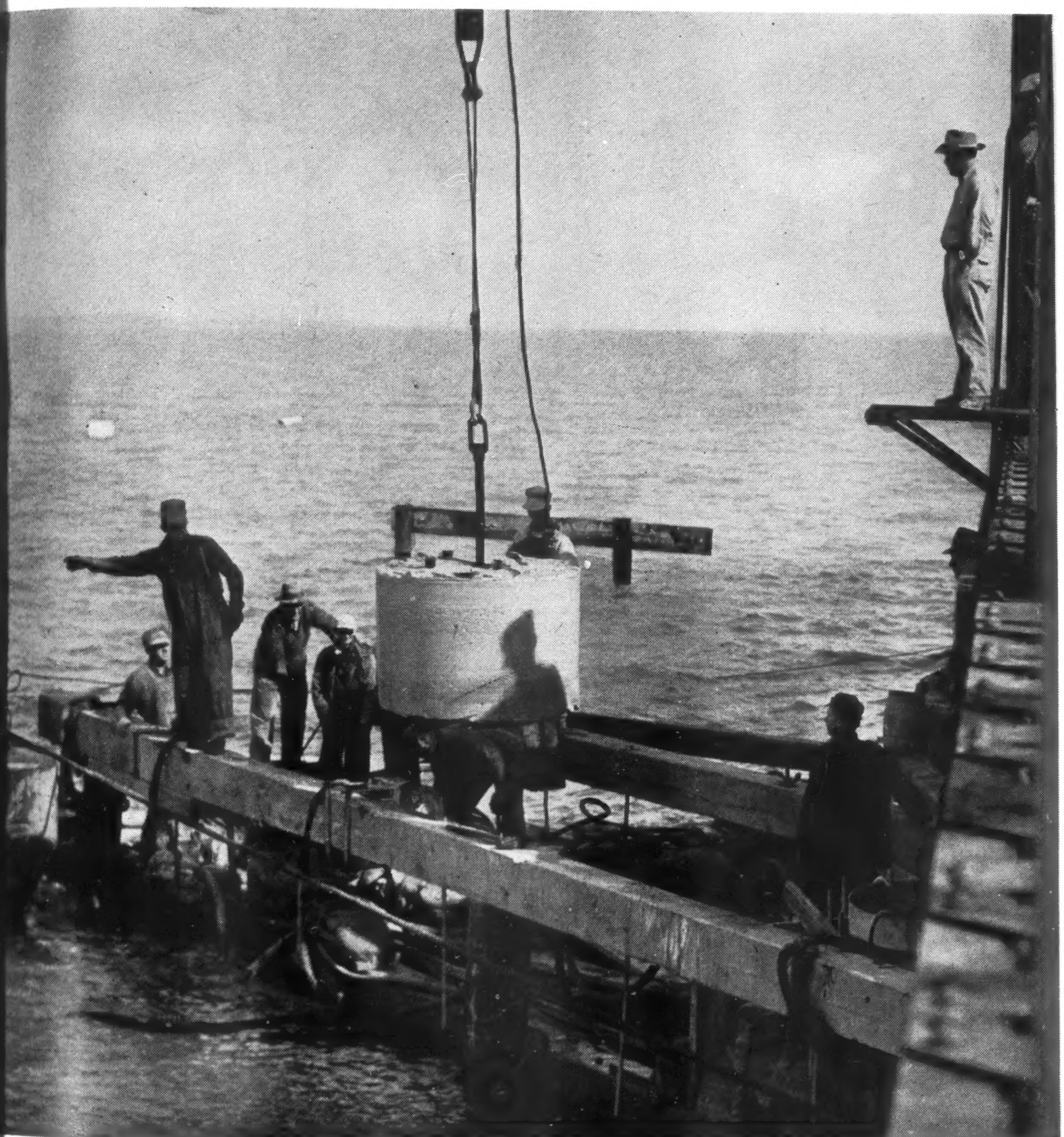
Compressed Air Magazine

JUNE 1946



BEDROCK SAMPLE
FROM LAKE ERIE

Lifting a 54-inch cylinde
from boring made to pou
concrete for bridge pie

(See article, page 153)

VOLUME 51 • NUMBER 6 NEW YORK • LONDON

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ON THE COVER

AT THE height of the war, when railroad traffic was at its peak, engineers were given the problem of replacing a series of 93-year-old pile trestles on the main line of the New York Central Railroad without interrupting train schedules. The section concerned was the double-tracked crossing of Sandusky Bay, an arm of Lake Erie in Ohio. Explosives obviously could not be used, so a method of excavating for new concrete-pier supports had to be followed that would not disturb the existing structure. The problem was solved by extracting cores from the limestone lake bottom with a Calyx core drill. However, because the set-up for this machine ordinarily includes a high derrick for handling the tools and cores and because the headroom available was only 52 inches, it was necessary to alter the unit so it would meet the space limitations. The cover picture shows a floating derrick removing a core that had just been lifted from one of the holes.

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IN THIS ISSUE

ONE of the few central power-generating stations built during the war was placed in service last December at Bainbridge, N. Y., by the New York State Electric & Gas Corporation. Restrictions on materials dictated certain departures from conventional construction practices, but these were accomplished without sacrifice in operating economy and efficiency. Most central stations are in or near cities, but this one has a rural setting. It is described in our leading article.

●

TO SHORTEN the rail line between Cleveland and Toledo, Ohio, pioneer builders constructed a section of it on a timber trestle across Sandusky Bay. Severely beaten by the elements, it had to be abandoned, but was restored to service by dividing it into five bridges, with intervening stretches of rock fill. Even so, costly and unending maintenance was still required. Now the wooden spans have been replaced with concrete-and-steel structures. Page 153.

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ENEMY forces planted in Allied sea lanes a type of acoustic mine that the rhythmical beat of a ship's propeller would explode. To thwart them, our Navy rigged up pneumatic tools to produce the sound waves by which they could be detonated harmlessly. Page 160.

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OFFHAND one would not associate pneumatic tools with the manufacture of paperboard boxes. Yet they were adopted during the war to replace traditional manual operations and were found to have many advantages.

Compressed Air Magazine

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EDITORIAL CONTENTS

A Power Plant in the Country—*C. H. Vivian* 146
Reconstructing a Bridge Under Wartime Traffic—*J. D. Jacobs* 153
Acoustic Mines Fired by Pneumatic-Tool Beats—*R. G. Skerrett* 160
Stripping Paperboard Boxes with Air—*Allen S. Park* 162
Movies Show Mining and Tunneling Operations 165
Midget Life Saver 166
Charles Frank Schwep 167
Self-Sufficient Burrows for Humans 167
Editorial—Missouri River Plan 168
Industrial Notes 169
Industrial Literature 172

ADVERTISING INDEX

Allis-Chalmers Co. 13
American Air Filter Co. 25
American Brass Co., The 9
American Leather Belting Assn. 10
American Optical Co. 26
Audel Publishers 18A
Bethlehem Steel Co. 32
Bucyrus-Erie 31
Combustion Eng. Co 23
Compressed Air Magazine Co. 37
Conrader Co., R. 39
Cook Mfg. Co., C. Lee 16
Crane Co. 17
Dollinger Corp. 3
Eimco Co., The 6, 7
Electric Machinery Mfg. Co. 45
Fairbanks Co., The 43
Fluor Corp., Ltd., The 11
France Packing Co. 20
Garlock Packing Co. 39
General Electric Co. 4, 36
Goodrich Co., The B. F. 22
Hercules Powder Co. 38
Hose Accessories Co. 40
Industrial Clutch Corp. 29
Ingersoll-Rand Co. ..... 15, 34, 2nd. Cover
Johnson Corp., The 41
Koh-I-Noor Pencil Co. 35
Koppers Co., Inc. 44
Logan Engineering Co. 35
Madison-Kipp Corp. 8
Mine Safety Appliances Co. 41
Murphy & Co., Jas. A. 40
New Jersey Meter Co. 37
Nicholson & Co., W. H. 40
Niagara Blower Co. 19
Norgren Co. 37
Norton Co. 18
Powell Co., The Wm. 30
Rhoads & Sons, J. E. 42
Roebling's Sons Co., John A. 24
Shell Oil Co., Inc. ..... 3rd. Cover
SKF Industries Inc. 33
Square D Co. 41
Swartwout Co., The 39
Texas Co. 5
Timken Roller Bearing Co., The ..... 4th Cover
United States Rubber Co. 28
Victaulic Co. of America 21
Vogt Machine Co., Henry 27
Walworth Co. 12
Waukesha Motor Co. 14
Westinghouse Air Brake Co. 35

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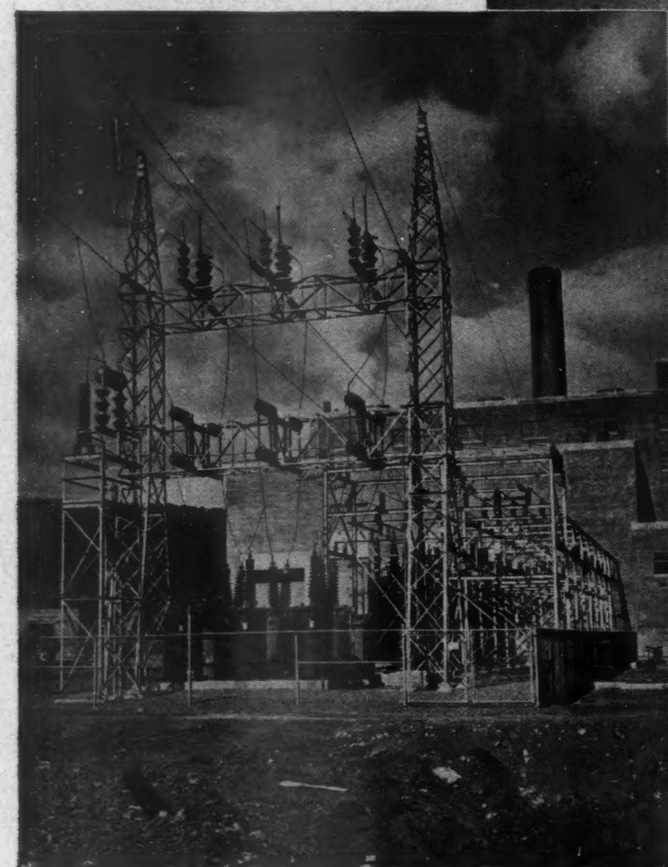
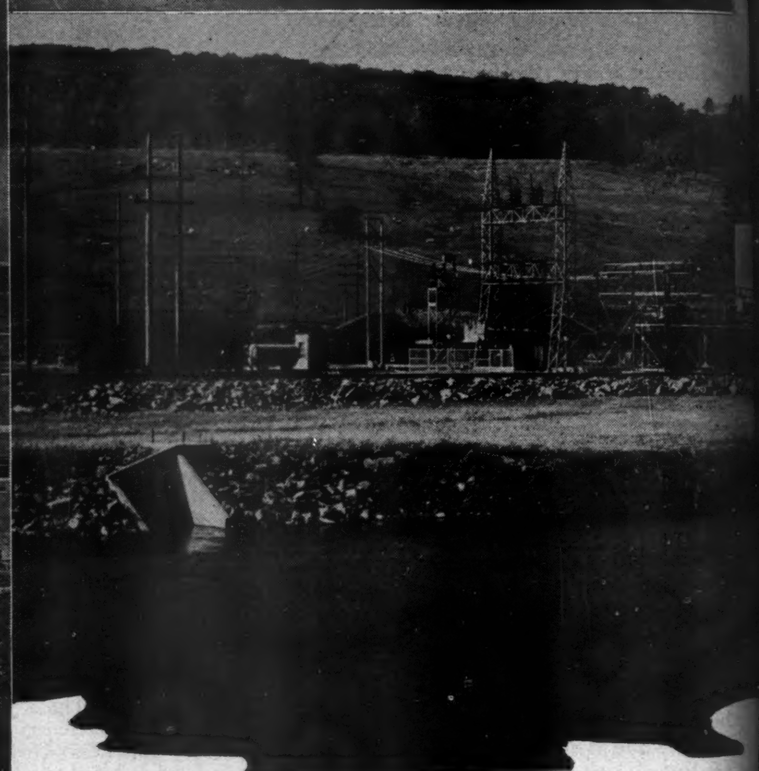
A Power Plant in the Country

C. H. Vivian





LAST DECEMBER the New York State Electric & Gas Corporation placed in service at Bainbridge, N. Y., a new 30,000-kw. steam-operated generating plant that is of interest for several reasons. Planned and built during the war, it exemplifies simplicity of design and conservation of critical materials with no sacrifice in reliability and efficiency. Despite the scarcity of labor, shortages of many components, and the handicaps of severe winter weather, it was completed and operating only seventeen months after ground was broken. It bears the name of Jennison Station, a designation that honors Ralph D. Jennison, president of the corporation and the moving spirit behind the plant's conception and construction.

The New York State Electric & Gas Corporation furnishes electricity to eleven cities, 138 villages, and the intervening rural areas in 42 counties. The principal region it serves is the tier of counties in south-central New York extending roughly from Dansville on the west to within a few miles of the Hudson River on the east, and from the Pennsylvania line on the south to beyond the Finger Lakes on the north. Although it supplies numerous localities that are rather highly industrialized, this utility looks to the farmlands and villages for much of its electrical load. The rural sections of its territory are devoted largely to dairying; in fact, they provide much of New York City's milk. The surface soil, which was deposited eons ago by glaciers that moved down from the north and then receded, is suitable for growing an excellent grade of hay for feeding dairy herds. Heavy yields are assured by ample rainfall and a generally favorable climate.

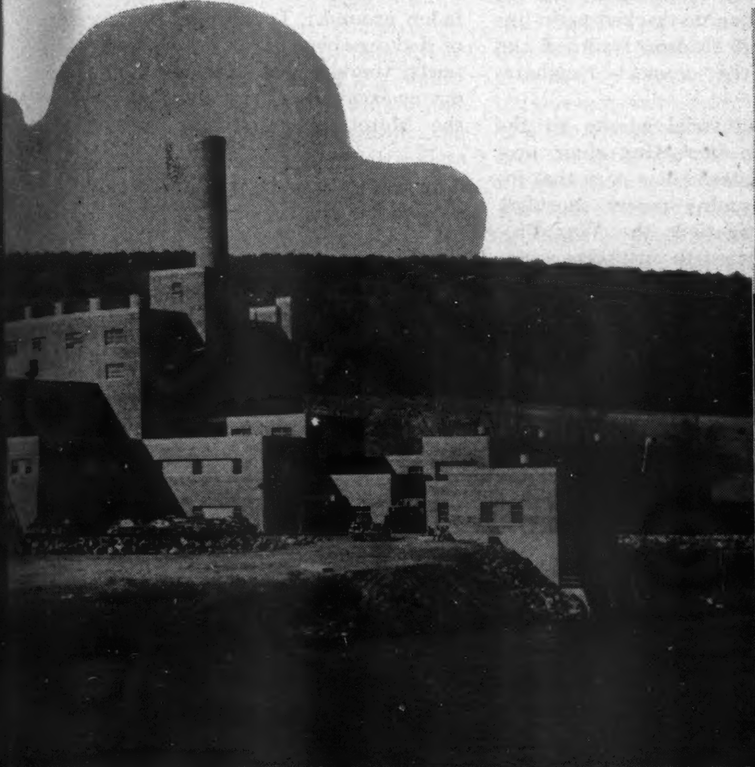
The large metropolitan dairying companies have established plants throughout the area to which the farmers send their milk for processing. These creameries drive their machinery with motors, and there is also a large and growing demand for electricity from the farmers themselves. About 80 percent of the farms in the territory are electrified, as compared with around 50 percent in the country as a whole. Farm customers at the close of 1945 numbered 41,000, an increase of 10,500 during the past five years.

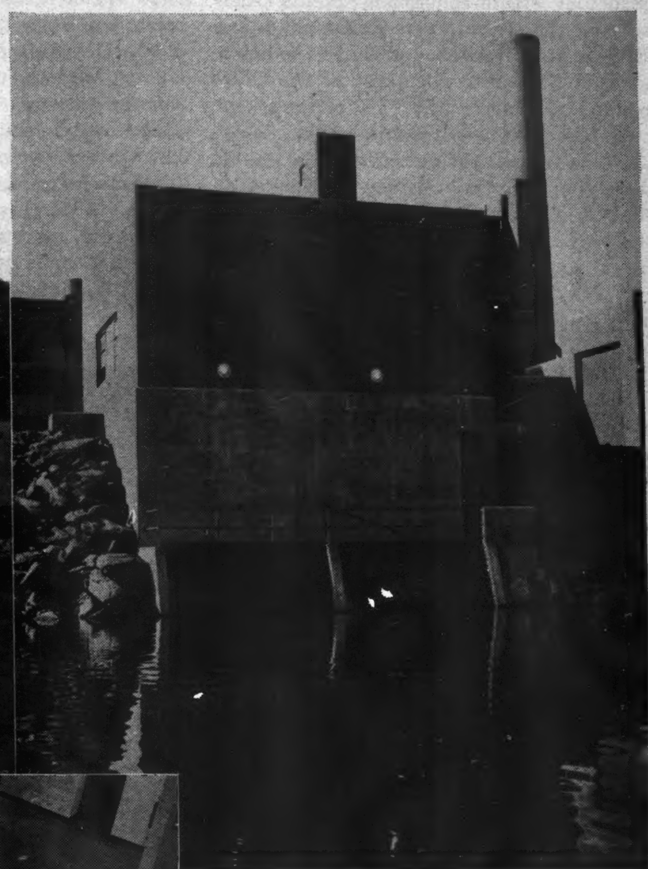
In 1945 alone, $2,700,000 was spent on

the company's rural electrification program. During the past two years nearly 3000 miles of additional distribution lines were built and placed in service. Over a ten-year period there has been a gain of 130 percent in the number of farm customers, compared with a gain of 25 percent in nonfarm residential customers, or a ratio of more than 5 to 1. There are more than 200 established productive uses of electricity on the farm, and it is the function of the company's farm-service department to demonstrate to farmers that electricity can, when properly applied, help maintain their incomes by decreasing the unit cost of production.

Many of the farmers have electrically refrigerated milk coolers and motor-operated water pumps. They light their homes and farm buildings with electricity, and many of them heat their water with it, the utility granting them an attractive night rate for this purpose. Barn hay-curing systems using motor-driven fans are being introduced, and the company is making headway in showing dairymen how to beat "Old Man Weather" and at the same time improve the average quality of their hay. The average farm consumption of electricity in 1945 was 1910 kw-hrs. per customer; the average revenue $62. The company predicts that consumption will reach 3000 kw. by 1950.

Decisions to erect new generating stations are not made overnight. Plans are drawn far ahead, so that additional electrical energy may be provided when the need for it arises. How well our power companies look into the future was made known during the recent war. The demand for current rose suddenly and pre-





GENERAL VIEWS

Two years ago wheat grew where the Jennison Station (center) now stands beside the Susquehanna River. The outer walls are of red brick, with glass-block panels supplementing the windows to increase interior daylight. The view at the extreme left shows the substation where the voltage of the generated power is stepped up to meet transmission-line needs. The 30,000-kw. hydrogen-cooled turbine generator is shown at the left with an end of the condenser visible at the bottom. Outwardly, the two huge stokers (top of opposite page) are as clean as grandmother's kitchen range. Although anthracite coal is now burned, the furnaces are designed so that stokers suitable for handling bituminous coal may be put in if a change in fuel is made. The screen house at the intake of the tunnel that conveys river water to the condenser circulating pumps is shown above. Provision is made for using the warm condenser discharge water for thawing ice at the intake in the event of bad winter freeze-ups.

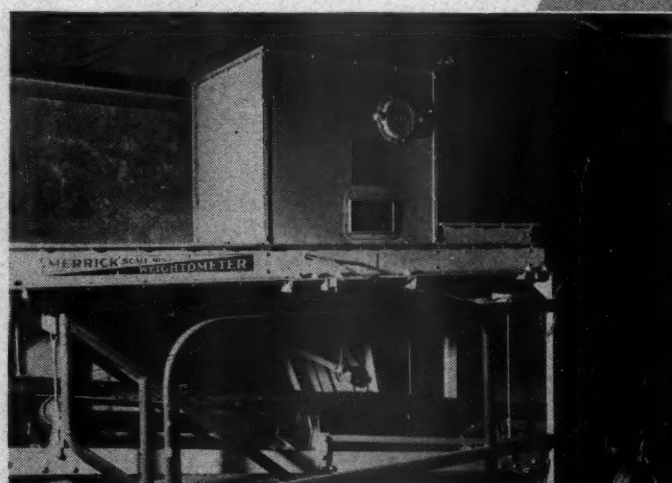
cipitously, but the facilities were available to meet it, and our war plants hummed day and night at full capacity.

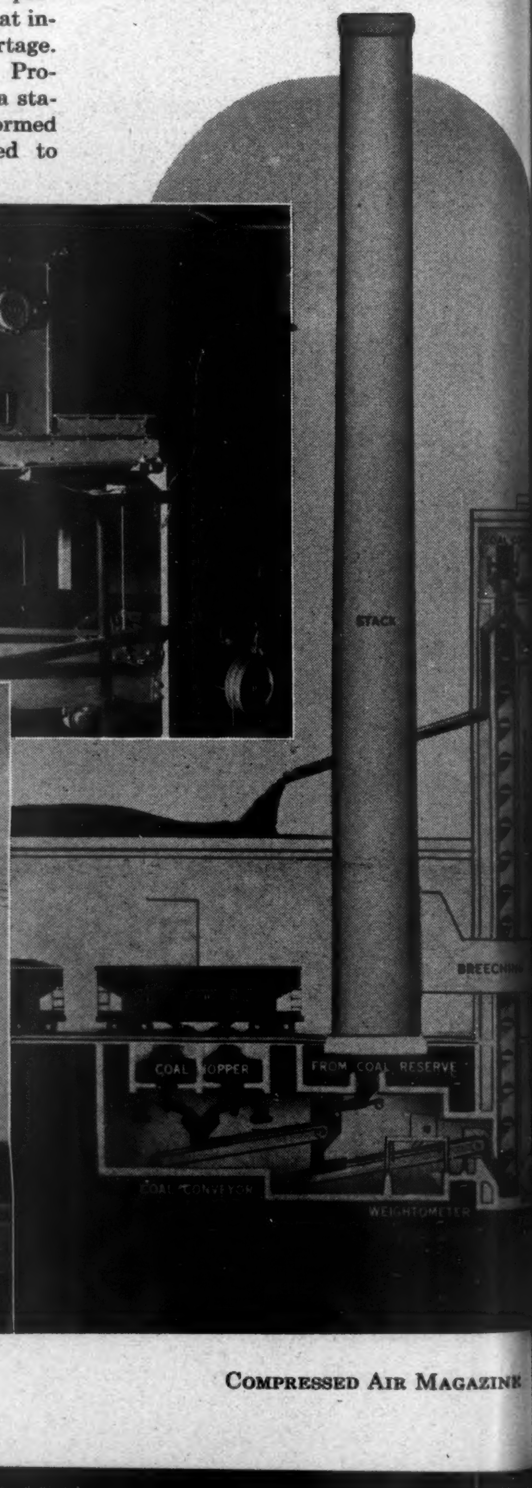
In line with this policy, the Jennison Station was in the minds of the engineers long before it was constructed. Early in 1942 the corporation conducted a study in the central part of its territory, and this showed that the average hourly power demand had increased at the rate of 7400 kw. annually from 1932 to 1939. A year previously, the Federal Power Commission had estimated the future growth at 10,000 kw. annually, and the investigations concurred with this figure. The principal steam-generating plants then serving the section were at Binghamton, Elmira, and Dresden, and they were being utilized almost to the limit of their dependable capacity. In view of these circumstances, it was recommended that a new steam-generating station be built somewhere in the vicinity of Oneonta. As this district, on the eastern fringe of the service area, was producing a relatively small amount of electrical energy and was at the end of a long transmission line, it was realized that a new power plant there would improve and stabilize the distribution system.

Following its decision to proceed with the project, the corporation engaged Gilbert Associates, Inc., of Reading, Pa., as consultants to lay out the station and to oversee its construction. Permission of the War Production Board to go ahead was granted in March, 1942, but was rescinded seven months later. Meanwhile, preliminary design studies had been started, and a number of possible sites investigated as regards railroad service, soil and flood conditions, availability of condensing water, etc. It was elected to continue these endeavors so that everything would be in readiness to place orders for equipment and materials as soon as government sanction was forthcoming. The location that was eventually selected is 1 mile south of Bainbridge and 32 miles northeast of Binghamton. On one side is the Susquehanna River, which will supply ample condensing water for the two units that will ultimately be installed. On the other side is the double-tracked main line of the Delaware & Hudson Railroad and a state highway that connects Binghamton and Albany.

Meanwhile, industrial plants in the area served were increasing their production of war material at a pace that indicated a forthcoming power shortage. After due investigation, the War Production Board agreed to authorize a station at Bainbridge provided it conformed with certain specifications designed to conserve scarce materials needed for the war effort. A formal application drawn up along those lines was submitted on October 13, 1943, and approved on November 23, 1943. A general contract covering construction was awarded the George A. Fuller Company of New York, and it commenced work on a railroad siding to the site on January 18, 1944. Temporary buildings for construction purposes were then erected, and excavation for the power plant was begun on May 19.

As the foundation was to be carried 26 feet below the normal level of the river, which is less than 100 feet away, measures had to be taken to cope with the water-laden ground. To obviate the necessity of driving sheet piling or other wall supports, the site was predrained and kept dry as excavating progressed by means of the Moretrench wellpoint system, this





COAL HANDLING

Approximately 30,000 tons of coal is stored in a huge pile outside the station as a reserve supply (below). Incoming cars of coal are dumped in a hopper and moved by a conveyor system either to bunkers in the building or to outside storage. All of it passes over a device (right) that records its weight.

phase of the operations being conducted by the American Dewatering Corporation. A concrete mixing plant was set up and, when the pit reached final grade, a mat from 3 to 5 feet thick was placed over the entire floor area. Concrete side walls were then poured, forming a watertight "boat" on and within which the superstructure was to rise.

As construction activities entered the winter of 1944-45, there was a decided shortage of masons, steelworkers, electricians, and other craftsmen, and the weather turned unusually cold, temperatures reaching 28° below zero Fahrenheit. Bricklayers were able to work on an average only one day a week, and progress was being seriously impeded. Temporary enclosures of wall and insulating board were provided for the scaffolds and heated with four hot-air furnaces within the building and with salamanders spaced less than 10 feet apart so that bricklaying could proceed steadily. Gradually the structure took form, the equipment began to go in place, and at the time Japan capitulated the stokers were being made ready to kindle the first fires underneath the boilers. The station was started up in October and, after a test run, was put in commercial operation on December 1. It was formally dedicated on December 13.

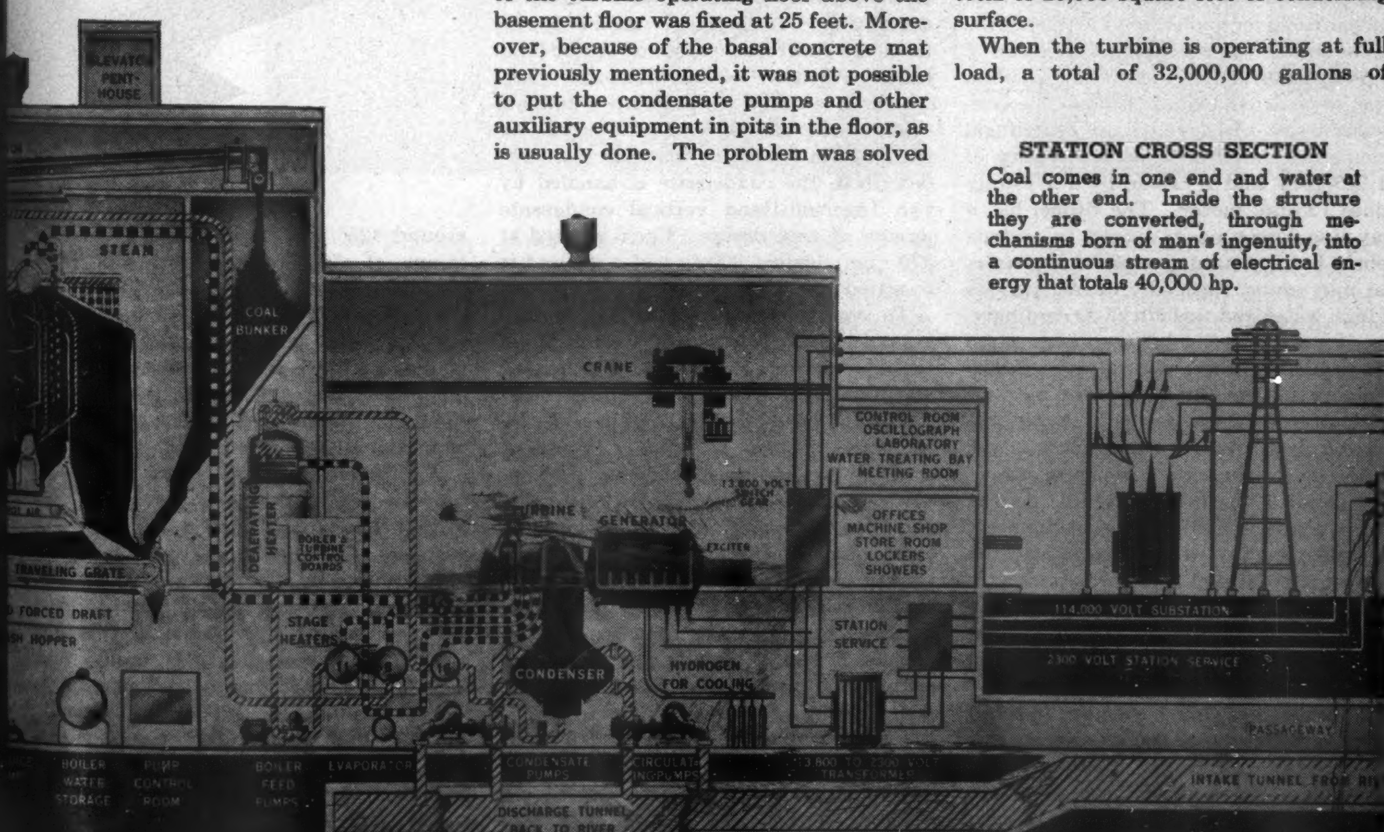
Jennison Station's power is produced by a General Electric 30,000-kw. turbogenerator. Its 18-stage condensing turbine is driven by steam under a pressure of 650 pounds per square inch and at a temperature of 825°F. The turbine is directly connected to a hydrogen-cooled generator. The tightly sealed casing is filled with this lightest of all gases under a pressure that is automatically limited to a maximum of 15 pounds per square inch. Being lighter and more tenuous than air, hydrogen offers less resistance to the rapidly revolving rotor. It also absorbs heat faster than does air and, consequently, is a better cooling medium. Since hydrogen is noncombustible when free from air there is no danger of fire or explosion. To compensate for the insignificant loss through leakage, additional gas is fed into the casing as needed from steel flasks in the basement. After extracting heat from the rotor, the hydrogen is cooled by coming in contact with tubing through which cold water is circulated.

When operating at full load, it is necessary to supply the turbine every hour with a volume of steam raised by evaporating 175 tons of water. As soon as the steam has done its work of spinning the turbine it is condensed—changed back into water—for reconversion into steam, and this cycle is repeated over and over. The condenser at the Jennison Station is of a new design so far as power plants are concerned, although it has been used on many ships, especially oil tankers that were built for fleet service during the war.

Ordinarily, a condenser and auxiliaries of sufficient size to serve a 30,000-kw. turbine would require at least 30 feet of headroom. In this case, however, to save critical construction materials, the height of the turbine operating floor above the basement floor was fixed at 25 feet. Moreover, because of the basal concrete mat previously mentioned, it was not possible to put the condensate pumps and other auxiliary equipment in pits in the floor, as is usually done. The problem was solved by choosing an Ingersoll-Rand twin condenser, which is in reality two condensers placed side by side and acting in unison. This design was developed to meet headroom limitations on shipboard—was literally made to order for the conditions at Jennison Station. Slightly wider foundations were needed than for a condenser of conventional design, but that was of no consequence because plenty of room was available laterally.

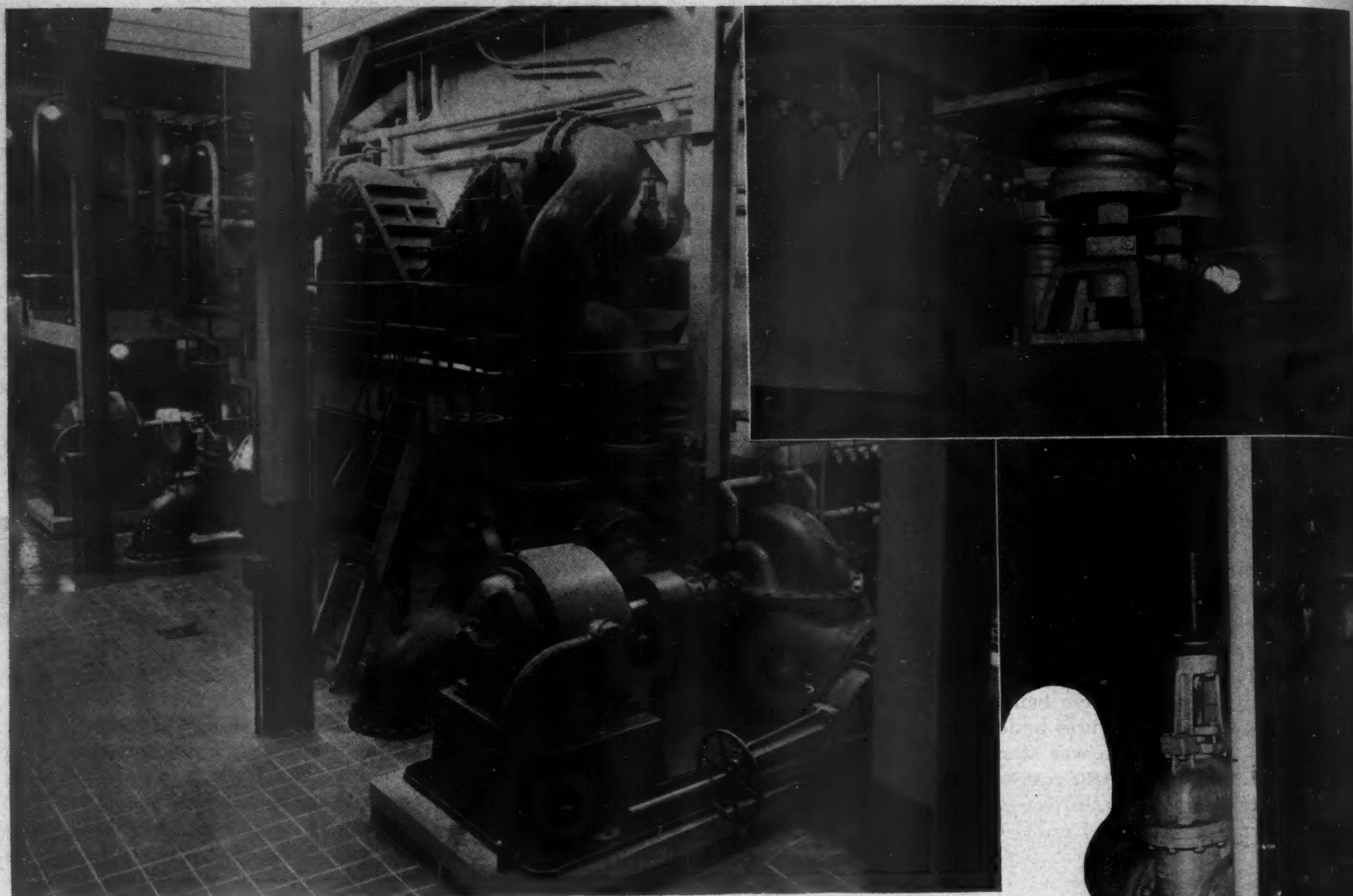
In addition to the all-important saving in height, the split-case condenser possesses several other points of merit. It is practicable to shut down either half of the unit for cleaning or inspection of tubes and water boxes while the other half remains in operation. The twin design also greatly simplifies shipment and erection in the field. A conventional condenser of the capacity in question would be transported in several pieces on several cars. Setting it up would involve bolting the shell together, welding in support plates, bolting on tube sheets, installing tubes, and assembling the water boxes. In contrast, each half of the Jennison Station unit was shipped completely assembled, with tubes and water boxes in place. It was erected by bolting the halves together and adding the separate connecting piece and hot well. Field welding and installation of tubing were eliminated. The condenser contains 4180 tubes, each 24 feet long and ⅞ inch in diameter and made of admiralty metal, an alloy with a copper base. The cooling water flows through these tubes, which provide a total of 23,000 square feet of condensing surface.

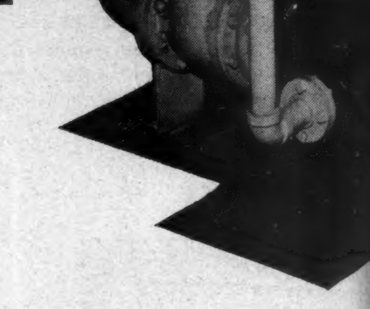
When the turbine is operating at full load, a total of 32,000,000 gallons of



STATION CROSS SECTION

Coal comes in one end and water at the other end. Inside the structure they are converted, through mechanisms born of man's ingenuity, into a continuous stream of electrical energy that totals 40,000 hp.





water flows through the condenser tubes every 24 hours. This is obtained by way of a concrete tunnel from the nearby Susquehanna River and is dosed with chlorine at the intake to prevent the formation of organic deposits that might foul the tubes. The water is circulated through the condenser by two Ingersoll-Rand centrifugal pumps, each of which has a capacity of 11,325 gpm. and is driven by a Westinghouse 125-hp. motor. The tunnel has a traveling screen at its intake to exclude debris, but a certain amount of fine material may enter, especially during periods of high water and turbidity. Accordingly, interposed in the line between each pump and condenser, there is a valve by means of which the flow can be reversed to clean the condenser when desired. Water discharged from the latter goes back to the screen house through a concrete tunnel that parallels the intake circuit. At the screen house it enters a 6-foot-diameter concrete pipe that discharges it into the river at a point 400 feet downstream.

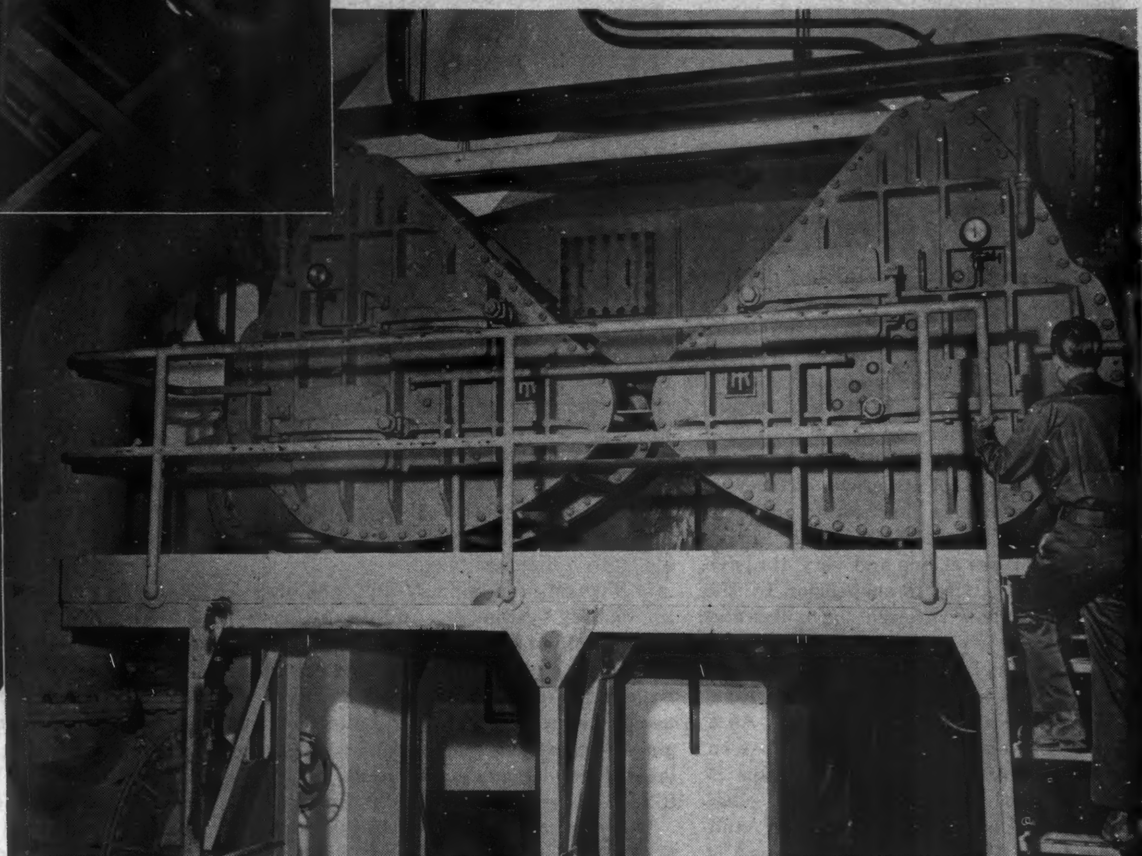
The main condenser is served by a 2-stage twin-element ejector with an inter- and after-condenser whose function it is to remove air that has leaked in. It does this by drawing a vacuum induced by steam jets operating in two stages. The condensate from the main-condenser hot well is pumped through the inter- and after-condenser to condense the steam used in its jets. The condensate then goes into a heater, where its temperature is raised to about 180°F. with low-pressure steam extracted from the sixteenth stage of the turbine. Next, it passes through a deaerating heater where steam drawn from the fourteenth stage of the turbine heats it to drive off air and other gases which, if allowed to remain, would accelerate corrosion of the boiler tubes. At the stage in its circuit that has just been described, the condensate is handled by two Ingersoll-Rand vertical condensate pumps of new design. Each is rated at 570 gpm. against 200 feet of head and is operated by a 50-hp. Westinghouse motor.

To compensate for losses that range around 1 percent, make-up water is added to the condensate at the deaerating heater, and the combined liquids flow to the suction of the boiler-feed pumps. There are three of these, of which two are ordinarily in use, leaving one as a spare. Two are motor-driven, while the third is equipped for operation either by a motor or a steam turbine. Owing to wartime restrictions, this is the only steam-driven auxiliary in the plant. The pumps are Ingersoll-Rand 6-stage centrifugal units and each has a capacity of 475 gpm. against 2120 feet of head. They force the water through two heaters, where high-pressure steam tapped, respectively, from the eleventh and eighth stages of the turbine raises its temperature to above 380°F. Then it goes through an economizer, where the coils are heated by flue gas. The water reaches the boilers at around 425° and is converted there into steam at 500° temperature and 675 pounds pressure. The temperature of the latter is raised to 825° in a superheater, and at that temperature and at 650 pounds pressure is delivered to the turbine. As the steam leaves the nozzles at the first turbine stage it has a velocity of more than 1900 miles an hour.

Boiler-feed make-up water is drawn from two shallow wells, from which also comes the supply needed for sanitary purposes. The boiler make-up water is treated in a zeolite softener and then evaporated. In case the wells fail to produce, equipment is available for treating river water so that it can be used. The fuel that is burned under the boilers serving the turbo-generator is anthracite coal. Although not novel, this is a departure from usual central-station practice that is made possible, of course, by the proximity of the plant to the anthracite field. Several industrial and utility power plants in Pennsylvania and New Jersey utilize

THE CONDENSER SYSTEM

As there was not room between the basement floor and the turbine level to house a condenser of conventional design, a marine-type unit with a split casing was adopted. The view below shows one end of it and illustrates its twin construction with the two halves acting in unison. In the foreground of the picture at the extreme left is one of the two centrifugal pumps that send 32,000,000 gallons of water daily through the 4180 condenser tubes to convert the steam from the turbine into water. This water, or condensate, is recirculated through two heaters by new design vertical centrifugal pumps shown in the center. It is then picked up by the boiler-feed pumps. An inter- and after-condenser (left) withdraws air from the condenser, inducing a vacuum by means of steam jets. The condenser is bolted to the bottom of the turbine exhaust, but is mainly supported on springs underneath it (opposite page).



anthracite, but in most of them it is fed to the stokers in pulverized form. That used at the Jennison Station is known as No. 4 Buckwheat which has about the same consistency as coarsely ground coffee. It is obtained partly from culm banks in the anthracite mining area of Pennsylvania and represents material that was formerly discarded because of its fine size. The principal source of the fuel is only 65 miles away, and its cost, delivered at the station, is approximately 60 percent of that of bituminous coal. When the plant is generating at capacity, it consumes around 17 tons of coal an hour, or eight carloads daily.

Cars of coal arriving at the siding are moved by the plant's own gasoline-engine locomotive. A track hopper house on one side of the building accommodates four cars and has facilities for thawing the coal with steam during periods of the year when that is necessary.

Underneath the track where the cars are thawed is a hopper than can take the entire contents of a 70-ton car. From there the coal is fed to a Link Belt Company handling system that has a capacity of 100 tons an hour. Reciprocating feeders move it to a conveyor belt that discharges onto a second belt. The latter carries the fuel over a Merrick Weightometer which keeps a running record of all coal received, of the percentages delivered to bunkers in the building and to outside storage, and of that reclaimed from outside storage. The belt transports it to a vertical bucket-type elevator that raises and dumps it into a chute leading to outside storage or onto another belt in the upper part of the structure. The latter belt carries it to a screw conveyor that feeds it as desired into either of the two 350-ton coal bunkers. A reserve supply of 30,000 tons is maintained in the stock pile and a bulldozer distributes the coal dumped on top of it or, when fuel from that source is needed in the plant, moves it to a belt that delivers it into the building at the head end of the conveyor system.

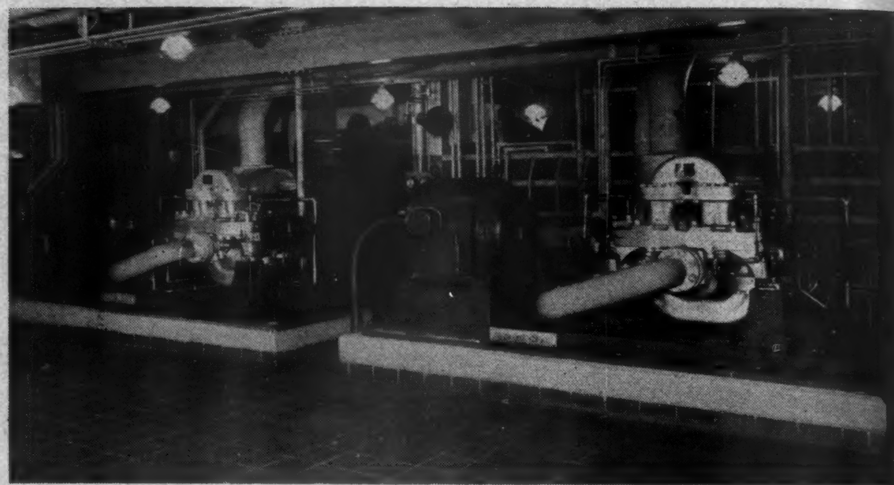
Because of the war-born shortage of steel plate, the bunkers were built of concrete. This involved the problem of designing them so that the coal, which ordinarily contains 10-12 percent moisture, would discharge freely—would not hang up on the sides. Working models were tested with fuels of various moisture contents, and those studies resulted in bunkers with three vertical sides and a fourth vertical for two-thirds of its depth and then sloping 50°. The inclined section was covered with tile to give it a smooth sliding surface. From these bunkers the coal flows through chutes, lined with stainless steel, to hoppers over the front ends of the stokers.

There are two Combustion Engineering Company 2-drum boiler units, each of which can deliver 200,000 pounds of steam an hour. They are substantially as high as a 6-story building. Their stokers rank among the largest ever constructed, each weighing 125 tons and being 24 feet wide by 28 feet long. The coal burns on travel-

ing grates made up of thousands of thin keys dovetailed to grate bars. The production of a boiler depends upon the thickness of the coal bed on the grate, and this is controlled by regulating the flow from the hopper that feeds it. At full boiler rating, the fuel bed is approximately 3¾ inches deep. The stoker grate is driven by a Louis Allis adjustable-speed motor, and its rate of travel can be varied between 14.8 feet and 90 feet per hour.

Air that is preheated to 290° is forced underneath the stoker and up through the grate by a Sturtevant forced-draft vane-type fan designed so that the pitch of the vanes can be adjusted to regulate the volume of air delivered. The underside of the fuel bed is divided from front to rear into nine compartments, each with a damper to control the volume of combustion air directed to it. The three rearward compartments are further divided into three zones, each of which has its own damper. An induced-draft fan draws the gases from each boiler to a brick chimney 11 feet in inside diameter and 150 feet high. At maximum station output, each stoker will consume 17,500 pounds of coal an hour, equivalent to 26 pounds for each square foot of its grate surface.

When small-size anthracite coal is burned in a furnace of this type, appreciable quantities of fine and very abrasive particles are carried in suspension by the combustion gases through the boiler and heat-recovery equipment. To minimize their effect, collecting hoppers to catch most of them are located at the bottoms of the first and last boiler passes. As a further protective measure, a Western precipitator of the multicyclone type is placed in the path of the boiler gases ahead of the economizer, air heater, and induced-draft fan. All this equipment is expected to reduce abrasion in the auxiliaries just mentioned and thereby extend the periods between shutdowns. The fine material that accumulates is blown into the furnace through the rear wall and burned. Ash is discharged over the rear end of the grate into a water-quenched hopper from which it is pumped periodically to a disposal basin.



BOILER-FEED PUMPS

Two of the three 6-stage pumps that charge 475 gpm. of water into the boilers against a pressure of more than 900 pounds per square inch. Each of these units is driven by a 400-hp. motor. A third identical pump is arranged for operation by either a motor or steam turbine.

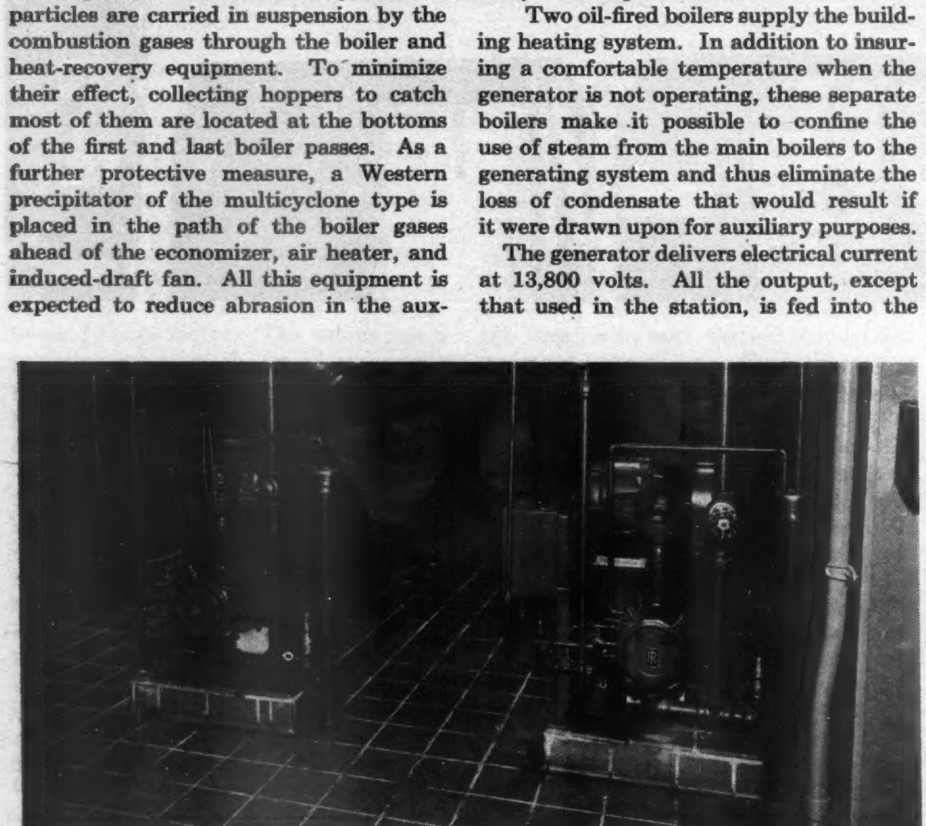
Two oil-fired boilers supply the building heating system. In addition to insuring a comfortable temperature when the generator is not operating, these separate boilers make it possible to confine the use of steam from the main boilers to the generating system and thus eliminate the loss of condensate that would result if it were drawn upon for auxiliary purposes.

The generator delivers electrical current at 13,800 volts. All the output, except that used in the station, is fed into the transmission system, about half of it being stepped up to 46,000 volts and the remainder to 114,000 volts. There are more than 100 motors in the plant, ranging up to 450 hp., and these operate on voltages of 2300, 440, and 208, according to their size.

The power plant is remarkably clean, as the accompanying pictures make plain, in pleasant contrast with older generating stations. The generator and boilers are installed on the same floor and only a short distance apart, with no wall between them. There is no need to protect any of the machinery from dust or grime, for the air within the structure is probably cleaner than that in the average city office building. Modern equipment and automatic controls not only make for dependable, uninterrupted service but also lighten labor. There is little actual physical work to be done in the plant, the chief duties of the attendants being to make certain that the mechanical robots at their command function as they are supposed to.

The entire force, including clerical help, numbers only 48 persons for the three 8-hour shifts, or only one for every 800-odd horsepower produced. There are machinists, pipefitters, and other artisans among the staff for carrying on maintenance work, and a shop, completely equipped, facilitates their services. Chemists analyze ten samples of water daily and make regular tests of lubricating oil, coal, and flue gas.

Steps are saved by an elevator that travels six stories and by two RCA paging systems. One of these covers the coal-handling area from the cars to the top of the plant, and the other one extends throughout the remainder of the station, with microphones and loud speakers located at all operating points and also in the offices, machine shop, etc. Drinking water is purified by ultraviolet rays.



AIR COMPRESSORS

Many devices in the station, such as feed-water regulators, drainers, and the combustion control system, are operated by compressed air that is supplied by these two units. They are designed to operate without lubrication to make sure that the discharged air will be free from oil that might clog piping and interfere with the proper functioning of the various pieces of automatic control apparatus.

Reconstructing a Bridge Under Wartime Traffic

J. D. Jacobs

New York Central Photo

OLD AND NEW

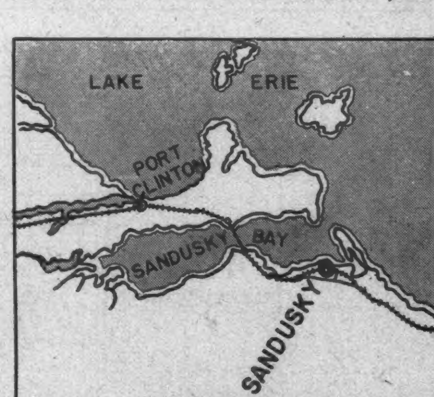
A freight train about to cross one of the old trestles is seen at the top. This view gives an idea of the forest of piles that accumulated during almost a century of recurrent strengthening of the structure to offset the damage done by natural forces. The other picture shows a section of Bridge 67 after its reconstruction on concrete piers securely anchored in bedrock.

FROM the mouth of the Maumee River, in northwestern Ohio, the southern shore of Lake Erie describes an almost unbroken arc between Toledo and Buffalo. The one major interruption in its regular sweep occurs where Sandusky Bay pokes inland about 60 miles west of Cleveland. Nearly a century ago, the builders of the pioneer Junction Railroad from Sandusky to Toledo surveyed a route which necessitated the construction of a 2-mile trestle across the narrows between shallow Sandusky Bay and outer Sandusky Harbor. The bridge, which was undoubtedly an ambitious undertaking for its day, linked the two sprouting lake ports of Sandusky and Port Clinton and also shortened the rail distance between Cleveland and Toledo by 6 miles. Train movement over the first bay bridge started in 1853.

What meager records are available of early railroading in that locality tell the story of a continuous battle with the forces of nature at this stretch of open water. Traffic interruptions were frequent. Ice gorges wrecked the bridge in winter, and during the other seasons storms swept in from the lake with a fury that cannot be belittled by present-day residents of that region. That the struggle seemed to be futile to the railroadmen of those days is indicated by the fact that, after the first five years of more or less regular operation, the officials of the line announced that the roadbed between Sandusky and Port Clinton would be "permanently" abandoned, inferring that there never would be sufficient traffic over the route to warrant the expense of maintaining a bridge across the bay. That announcement must have caused dismay in the Village of Port Clinton, whose patriotic citizens believed that it killed forever their city's chances of becoming the Metropolis of the West. Nevertheless, trains continued to detour the bay, going via Fremont, Ohio, during the fourteen years between 1858 and 1872.

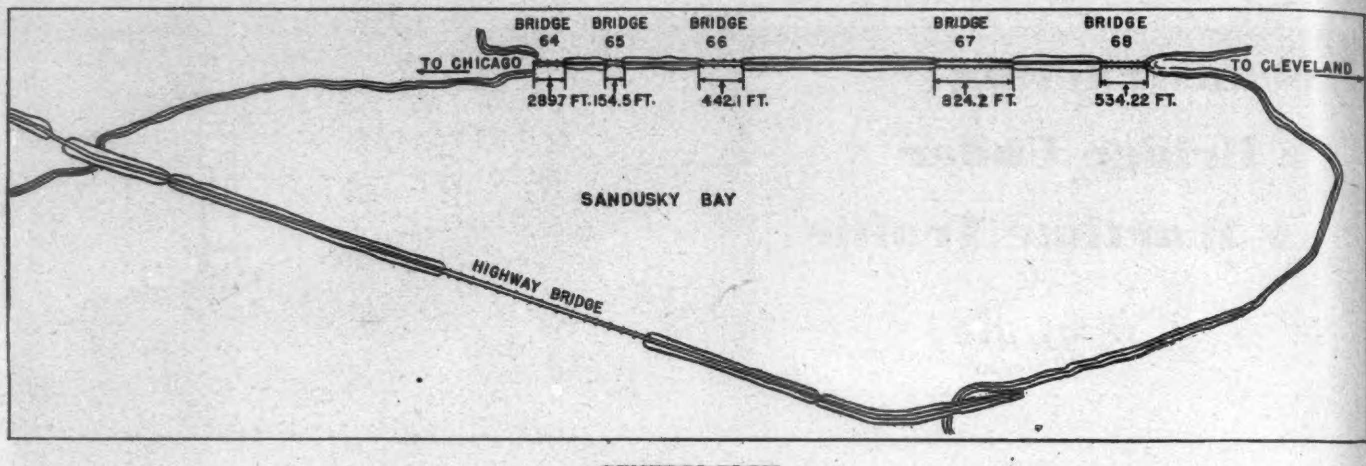
Meanwhile, several local lines between Buffalo and Chicago merged, and in 1869 was organized the Lake Shore & Michigan Southern Railroad. Rails then began to give real competition to sailboats on the lakes for the east-and-west freight business. The L. S. & M. S. immediately undertook to rebuild the bay bridge, and it was reopened in 1872. It was probably at that time that the continuous wooden structure from shore to shore was converted into a series of rock-filled causeways with trestles in between.

As the volume of traffic swelled, it was necessary in 1887 to expand by double-tracking, and in 1892 the old movable timber span was replaced with a double-track steel swing span on stone masonry. There has been no interruption in service since that time, but during the past 20 or 25 years the road has had to make extensive repairs annually and to employ a large force of men during the winter season to keep the trestles free from ice. The Lake Shore became a part of the New York Central System in 1915. Thus, early in the present century, the stretch of railroad that had once been abandoned as unworthy of maintenance became a part of one of the most important carriers of transcontinental traffic in the United States—the well-known Water Level



LOCATION SKETCH

The bridge across Sandusky Bay shortens the main line of the New York Central Railroad by about 6 miles. It was placed in service in 1853, abandoned five years later because of the difficulty of maintaining it, and then restored to use in 1872.



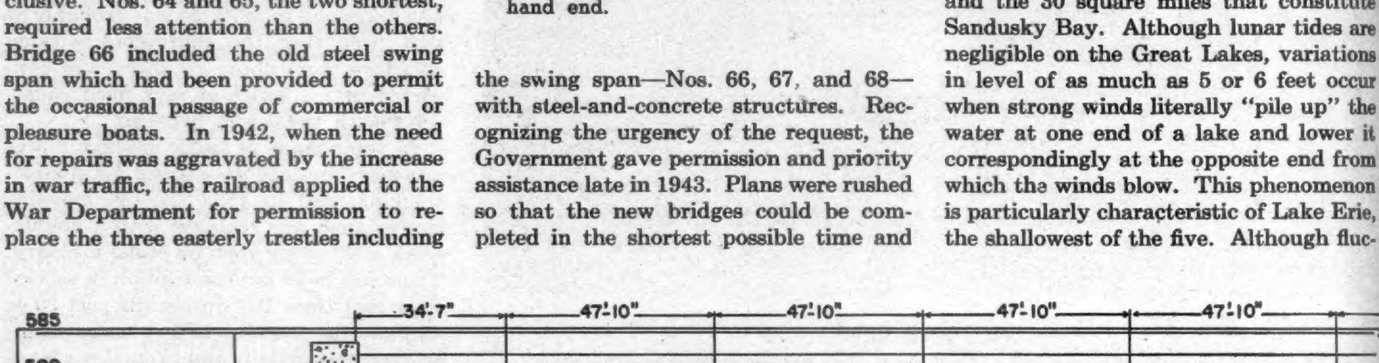
GENERAL PLAN

Bridges 66, 67, and 68 were rebuilt during 1944, and the remainder of the work was done in 1945. Bridge 64 was reconstructed, while the gap formerly crossed by Bridge 65 was filled in. An old lift span in the center of Bridge 66 was replaced with a bascule span located at the right-hand end.

Route between New York and Chicago.

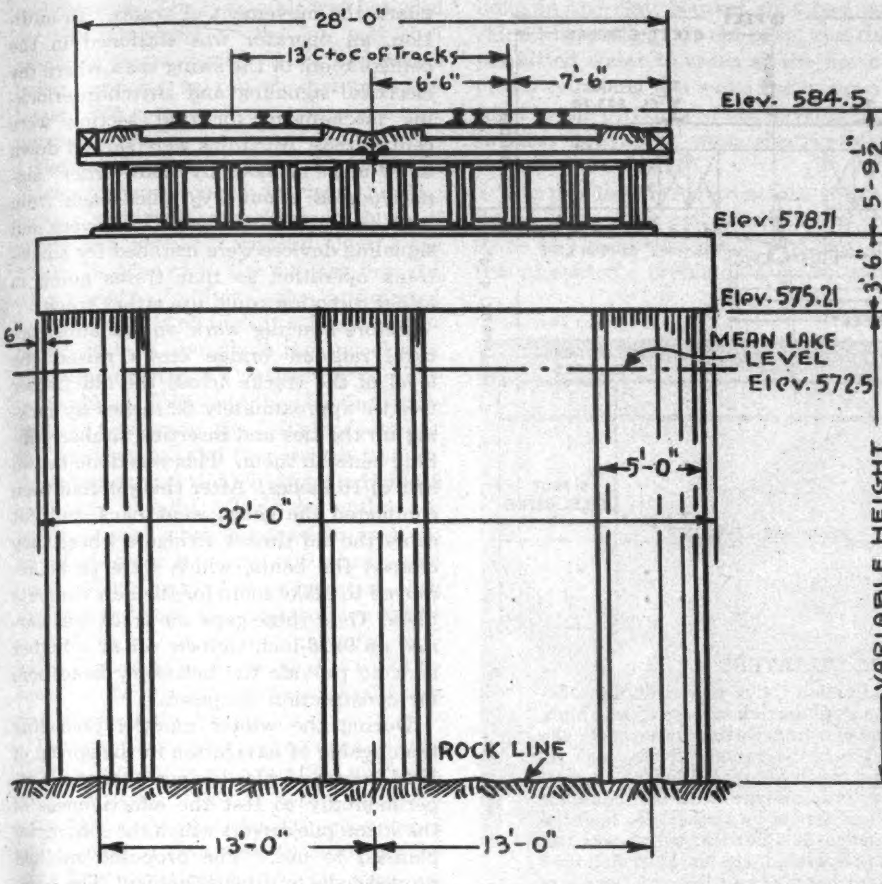
At the start of the recent war it was found that the five trestles across the bay were again in need of strengthening. The structures are identified in the New York Central records as Bridges 64 to 68 inclusive. Nos. 64 and 65, the two shortest, required less attention than the others. Bridge 66 included the old steel swing span which had been provided to permit the occasional passage of commercial or pleasure boats. In 1942, when the need for repairs was aggravated by the increase in war traffic, the railroad applied to the War Department for permission to replace the three easterly trestles including the swing span—Nos. 66, 67, and 68—with steel-and-concrete structures. Recognizing the urgency of the request, the Government gave permission and priority assistance late in 1943. Plans were rushed so that the new bridges could be completed in the shortest possible time and with a minimum of interference or delay to vital traffic.

The five gaps spanned by the pile trestles offered not more than just enough passageway for the strong tidelike movement of the water between Lake Erie and the 30 square miles that constitute Sandusky Bay. Although lunar tides are negligible on the Great Lakes, variations in level of as much as 5 or 6 feet occur when strong winds literally "pile up" the water at one end of a lake and lower it correspondingly at the opposite end from which the winds blow. This phenomenon is particularly characteristic of Lake Erie, the shallowest of the five. Although fluc-



LONGITUDINAL SECTION AND PLAN

A part of Bridge 68, showing the old timber piling that existed when reconstruction began and the positions of the concrete piers and abutment that replace it. It also shows the uneven lake bottom made up of clay, old cribbing, and miscellaneous scrap material that had been put in during almost a century of effort to maintain the lake crossing against the forces of ice, wind, and water. Obstructions had to be cleared away at each pier site so that the cylinders could be driven to bedrock, cored, and filled with concrete to insure a firm footing.



TYPICAL PIER

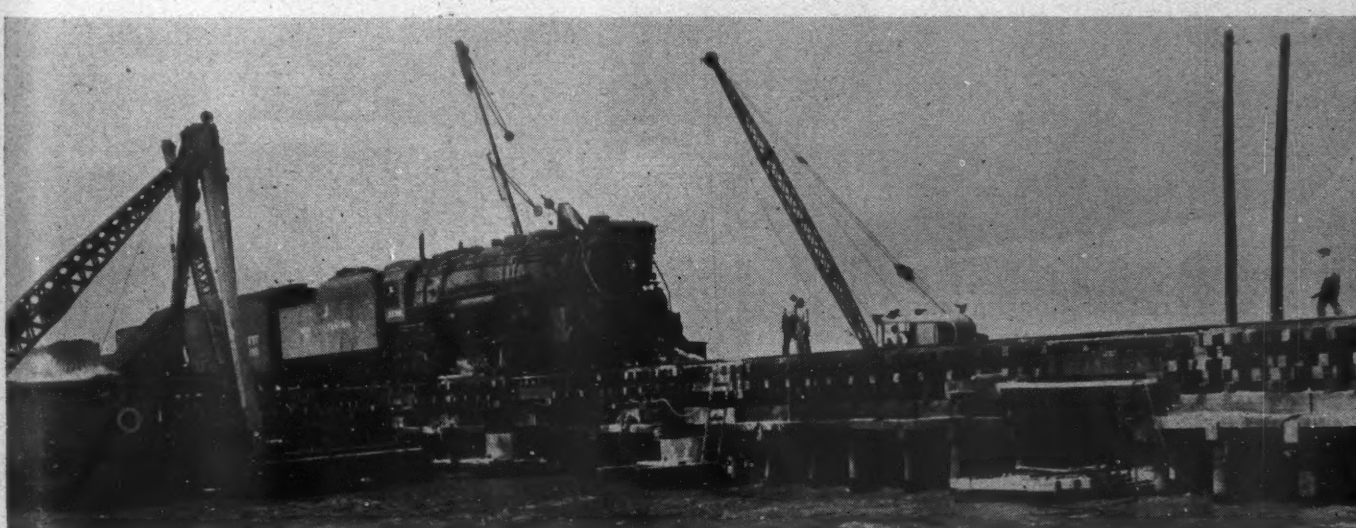
Cross section showing how the track superstructure is supported on three concrete-filled cylinders which are shown here resting on bedrock but which were actually carried down far enough to penetrate at least 4 feet of sound rock. Pier cylinders are 5 feet in diameter, while each abutment has two 8-foot outer cylinders and a central one of 5 feet. The reconstruction of three bridges by this method entailed the placing of 100 five-foot cylinders and sixteen larger ones.

tuations in water level didn't simplify the construction job, they undoubtedly served, like hazards on a golf course, to make the work of bridge building a more interesting sport for the contestants.

The new structures were designed as a series of rolled-beam spans supported by rigid reinforced-concrete bents spaced lengthwise on centers that had to vary from 35 to 48 feet in order to fit between the existing timber bents. With the exception of that section which replaces the old steel swing span, each of the bents consists of three reinforced-concrete cylinders extending to and firmly anchored in bedrock. They are encased in steel shells or jackets that are 5 feet in diameter and fabricated mostly from $^5/_{16}$-inch plate. The cylinders in each bent are spaced 13 feet, center to center. The intermediate one is located on the center line between the eastbound and westbound tracks. The tops of the three cylinders are tied together by a reinforced-concrete cap 6 feet wide and 3 feet 6 inches deep. Multiple-beam spans, extending from pier to pier and with their ends resting on bearing plates on top of the concrete caps, constitute the bridge superstructure. Most of them consist of five equally spaced 36-inch rolled beams under each track and are surmounted by a solid timber deck carrying the track ballast.

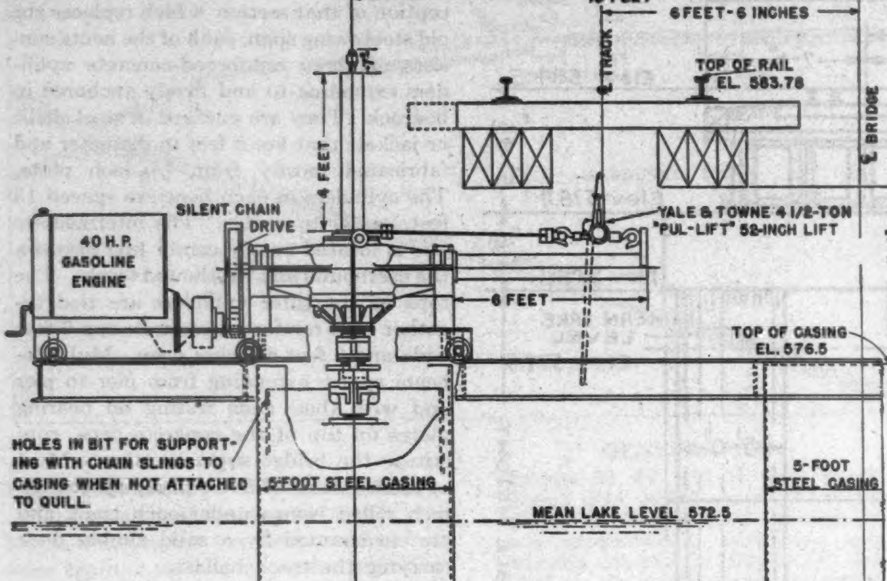
In deciding upon methods of construction, the first consideration was safety and maintenance of traffic movement. During the period the work was underway, as many as 130 trains passed over the bridge in a day. These included solid manifest trains transporting war material that had to arrive at particular ports at definite times and running on the closest of schedules. They could not be delayed under any circumstances. The New York Central's famous "fleet" of crack passengers—including the Twentieth Century Limited, the Commodore Vanderbilt, the Pacemaker, and the Paul Revere—crossed in both directions mostly during 2-hour periods in the early morning and late afternoon. Others that passed over without interference were the Mercury, the Water Level Limited, the Lake Shore Limited, and the Iroquois.

While construction was in progress, the railroad kept a trainmaster and two or three flagmen on duty continually to safe-



DRIVING CYLINDERS

Operations had to be conducted without delaying the passage of more than 100 trains daily. This picture shows platforms erected at pier sites for the use of the workers. Two partially driven cylinders may be seen at the left.



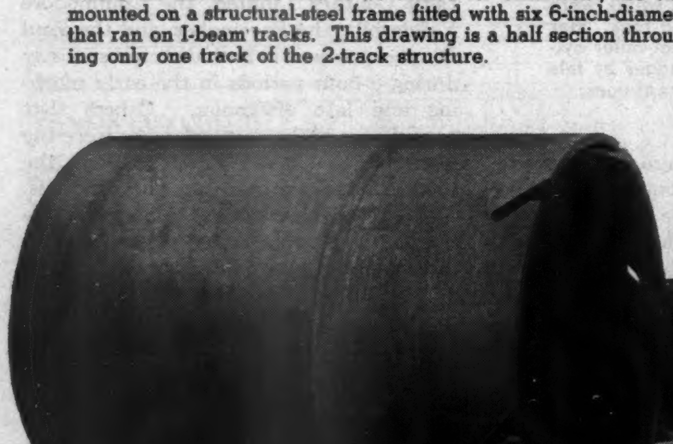
TAILORED TO FIT CLOSE QUARTERS

In ordinary work where there is unlimited headroom a Calyx core drill of the 54-inch size that was used on this job is served by a steel derrick at least 40 feet high. In this instance, however, the rig had to be moved transversely underneath the existing bridge where there was only 52 inches of clearance. It was also required that the top of the unit should not extend much above rail level. To meet these conditions, the drill was provided with a trunnion-type head that could be laid over at an angle of 90 degrees when the unit was to be shifted. To feed the core barrel at the desired pressure in the absence of a derrick, a line was run out of the cylinder and over a sheave to a hand-operated 4½-ton hoist stationed at one side of the rig, as shown. The tools were handled and the rock core was removed from the cylinder by a floating derrick. To permit moving the drill and its 40-hp. gasoline-engine driver laterally beneath the bridge to the locations where the three holes had to be drilled for each bent, the entire assembly was mounted on a structural-steel frame fitted with six 6-inch-diameter flanged wheels that ran on I-beam tracks. This drawing is a half section through a bridge showing only one track of the 2-track structure.

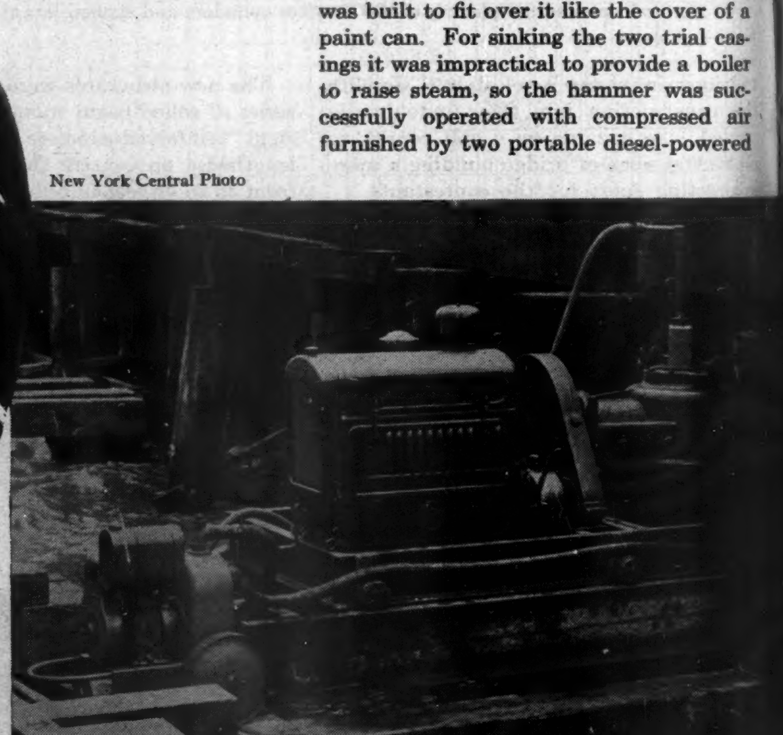
guard the movement of trains. In addition, an operator was stationed in the control room of the swing span where the electrical signaling and switch-interlocking mechanisms for that section were centralized. All trains were slowed down to 10 miles an hour by "slow-order" signals posted about 1½ miles back from both ends of the bridge. Crossovers and signaling devices were installed for single-track operation so that trains going in either direction could use either track.

Before starting work on the substructure, railroad bridge crews raised the level of the tracks across the old timber trestles approximately 32 inches by jacking up the ties and inserting timber cribbing beneath them. This was done in two lifts of 16 inches. After this job had been completed the gangs went back and cut away the old timber stringers where they crossed the bents, which were to be removed to make room for the new concrete piers. Over these gaps the track was carried on 9x18-inch timbers set at a higher level to provide the necessary headroom for construction purposes.

During the winter months preceding the opening of navigation in the spring of 1944, two steel pier casings were sunk experimentally to test the effectiveness of the steam pile drivers which the contractor planned to use. The proposed method proved to be quite satisfactory. The hammer was of the double-acting type with an enclosed frame and delivered about 9000 foot-pounds of energy per blow. To transmit that force evenly around the top edge of the shell, a circular driving head was built to fit over it like the cover of a paint can. For sinking the two trial casings it was impractical to provide a boiler to raise steam, so the hammer was successfully operated with compressed air furnished by two portable diesel-powered



New York Central Photo



CORE-DRILLING OPERATIONS

Three views showing details of the compact Calyx-core-drill assembly designed to pass underneath the bridges. By means of the abrasive action of steel shot fed under the bottom edge of a revolving hollow cylindrical bit (above), this machine cut 54-inch cores in the limestone bedrock. At the extreme lower-right is seen the horizontal attachment to the head for mounting the hoist that was used to support some of the weight of the bit during drilling to obtain the pressure necessary for most effective cutting. Ice formed by the freezing of splashing lake water is visible in parts of the picture at the upper-right that was taken in April, 1944.

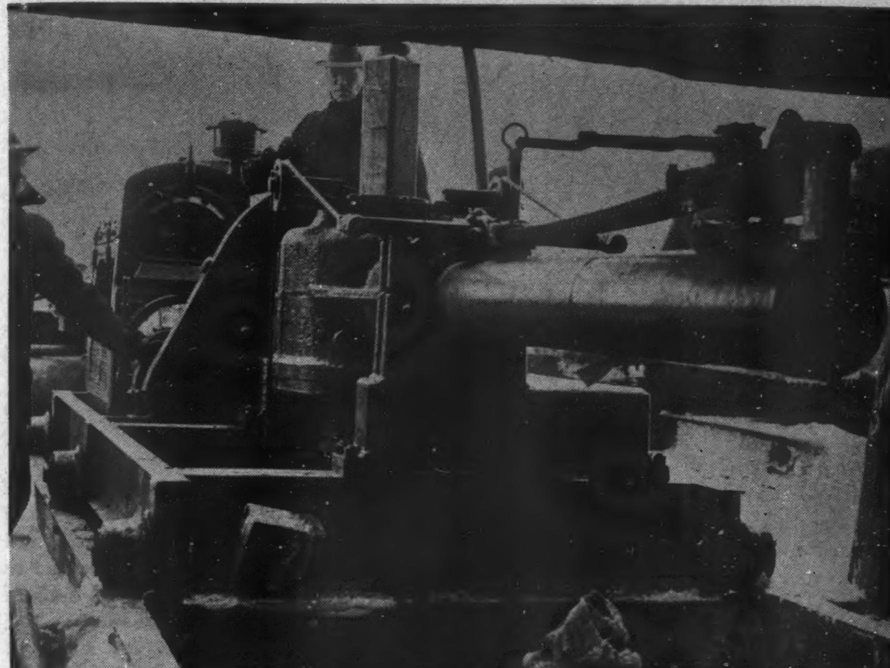
compressors. The reason air was not used for the remainder of the job was that available steam derrick boats had ample boiler capacity to run the hammers, releasing the compressors to supply air for pneumatic tools and sump pumps.

Before the steel shells could be set in place, it was necessary to clear the lake bottom of old piling and riprap, some of which had probably reposed there since 1853. Besides rock, the dredges brought up a variety of old car axles, antiquated tools, and parts of ancient railroad equipment—in fact, enough to have stocked a museum devoted to nineteenth century railroading. Following the cleaning operation at a pier site, the cylinders were set in a guide frame and then driven to rock. Once begun, the sinking of an individual shell was usually carried on without a pause, except when required to weld on an extension or to permit the passage of a train. Working in close coöperation with the railroadmen, the construction crews started to set or drive a cylinder only when there was no doubt that it could be sunk below rail level before a train was due to reach the bridge.

In most cases there was no need to stop driving in order to excavate the clay from within a shell. Only in a few instances were deep-lying obstructions encountered which made it necessary to interrupt the work long enough to remove the mud and impeding object. Excavating was done with a 9-cubic-foot orange-peel bucket that was swung from the boom of a floating derrick moored alongside. As mud removal progressed, the water level inside the casing was lowered by the use of pneumatic sump pumps. The stiff clay proved to be an effective seal against the inflow of water so long as the material in the shell was some distance above the rock surface. In many places there were holes in the clay blanket that had been caused by pulling out old piles, and these permitted water to enter at the bottoms of the cylinders. To make the latter conform to the contours of the irregular rock surface, extensions were electric-welded to their lower ends.

The pier design required that the reinforced concrete be embedded in firm limestone to a minimum depth of 4 feet, and this presented a problem. For fear of disturbing the adjacent timber piles which carried the railroad bridge, the use of an effective amount of explosives was not permissible. On the other hand, with only sufficient room for one man, it would have been a slow and expensive job to line-drill the perimeter and chip out the rock core in small pieces. Early in the planning stage, someone had conceived the idea of employing a large Calyx core drill for this work. Ingersoll-Rand Company repre-

New York Central Photo



SETTING FIXED SPAN

After new piers and abutments were completed, the bridge superstructure was replaced a span at a time. Here is shown a section, built to exact length, as it is being substituted for an old span that had been lifted out. The shift, including relaying of the rails taken from the old section, was often made in an hour.

sentatives were called in and, in conjunction with the contractor's engineers, designed a Calyx rig with a 54-inch barrel and a special gasoline-powered driving head.

Headroom under the existing bridge being limited, the drilling mechanism had to be tailored to fit the job. To reach the middle cylinder in each group of three without interfering with the passage of trains, the whole rig had to be moved transversely from casing to casing. This difficulty was overcome by equipping the frame of the drill with flanged wheels. Steel hangers were attached to opposite sides of each shell in a pier to carry 12x12-inch timbers. Across the latter were placed 8x8-inch timbers to which 30-pound rails were spiked to form the track. Once the derrick had set the core drill on the transverse frame it could be pushed easily by hand into operating position. The timbers in this structure were used afterward to support the forms required in pouring the concrete cap.

Preparatory to core-drilling, a man entered the dewatered casing and in the center of it drilled a vertical hole about 5 feet deep in the rock with a Jackhamer. This hole provided a means of removing the core. Before spotting the Calyx drill over the shell, the core barrel, with its sectional driving shaft, was assembled on the deck of the work scow alongside and then lifted and lowered by the derrick. The power unit was then moved into position, and after it was coupled to the vertical shaft the cutting operation began, the core barrel often advancing as rapidly as 2 feet an hour.

After the Calyx drill had reached the specified depth, the next job was that of removing the core. Often, because of seams in the rock, the core was fractured into a number of pieces, and these had to be hoisted out of the casing with a bucket. Sometimes a natural horizontal plane near the bottom of the core made it possible to lift it out intact without the trouble of breaking it loose. But when the formation was solid, it was necessary to "pop" the core loose by exploding a charge of dynamite at the bottom of the Jackhamer hole. The amount of explosives required to accomplish this was too small to cause apprehension as to the structural soundness of the bridge.

Aside from the predictable difficulties incident to working in extremely cramped quarters and to maintaining precautions at all times to insure safety of traffic, the most perverse source of trouble was the inflow of water at the bottoms of several of the steel shells. This usually happened after a cylinder had been driven and the clay had been excavated down to rock. Sometimes the lake water found its way in by seeping down the exterior of the shell—following the void left by the passage of its cutting edge through the clay. Such leaks could usually be stopped by dumping clay, cinders, or other material outside the casing to be drawn in by the inflowing water.

A thin stratum of pervious material at contact between clay and rock was a frequent source of water, and pressure also caused it to well up through cracks in the limestone. Conditions of this nature were more difficult to cure. Grouting proved to be the most successful method of counterattack. This was done in some cases by leading pipes down the inner surface of a shell and out through it in order to inject the grout into the surrounding zone just above the bottom edge. That procedure often proved successful.

In the most troublesome cases it was necessary to deposit a layer of concrete, 3 or 4 feet deep, by tremie on the bottom of a flooded cylinder. After the material had set and the casing was dewatered, Jackhamer holes were drilled through the concrete blanket into the rock. Pressure grout was then applied through pipes sealed in the holes. When the flow of water stopped, the concrete had to be removed by aid of the Calyx drill before excavating down into rock could be continued. With the hole made tight against infiltration, steel-reinforcing bars were placed inside the cylindrical shell and concrete was poured in one lift from the bottom to a construction joint nearly at lake level, approximately 4 feet below the bottom of the cap.

Concrete was batched, mixed, and handled by a portable plant erected on a wooden scow which could be towed to the desired location and moored alongside the trestle. It consisted of a set of aggregate bins with a weigh batcher, a belt conveyor, a stationary 1-cubic-yard mixer, and a Pumpcrete machine. The pipe-line method of conveying concrete from the mixer to the forms made it possible to carry on placing operations without interruption from passing trains. Following pouring of the cylinders in any one bent, the next step was the construction of the concrete cap on top of them. Wood forms were built in panels on shore, ferried to the site, and assembled upon the transverse beams that had previously provided support for the track on which the Calyx drill was moved from cylinder to cylinder.

The abutments of the bridges are generally similar to the intermediate piers except as to their cylinders. Instead of three 5-foot casings they are made up of two 8-foot-diameter shells with a 5-footer in the middle. The superstructure of the abutments carries a backwall on the landward side for the purpose of retaining the approach fill. The method of sinking the large cylinders differed only in minor details from that used for the smaller ones. Because only one size of Calyx core barrel was on hand, each hole was enlarged by line-drilling an 8-foot circle and breaking the rock into the center cut with paving breakers.

The steel spans were assembled and riveted together on shore, with the creosoted-timber deck bolted to the steel-beam structure. When a span was ready for placing it was laid alongside the track near the end of the bridge of which it was to become a part. During emplacement it was, of course, necessary to take one track out of service and run trains in both directions on the other track. This called for very careful planning and scheduling of operations in order to make the most

of the short working periods available.

Two derrick cars were used for handling the old and the new spans, some of the latter weighing nearly 60 tons. One car had the job of removing the rails and the old timber structure down to the pile caps. The rails were set aside for replacement on the new deck, and an entire bridge section between the new piers was lifted bodily and carried back to a disposal spot. Meanwhile, the other derrick car was bringing out the new steel span from the opposite shore for lowering into position on the concrete piers. Even with the delays caused by waiting for trains to pass on the adjacent track, it was frequently possible to complete the cycle of removing the old span, setting the new, and relaying the track in less than an hour.

The final operation called for the removal of the last remnants of the old structures—the forest of wood piling which still protruded above the water between the new concrete piers. The piles were either pulled out or, because their condition was such that they had little structural value, were broken off at the mud line and hauled to shore where they were stacked for drying and subsequent disposal.

The first three new bridges were put in service in the fall of 1944, leaving the two timber-pile spans 64 and 65 to be rebuilt. An application made by the railroad to the War Production Board brought permission to proceed with the replacement during the 1945 season. Because of the elimination of the closely spaced wood piling in the case of Bridges 66, 67 and 68, the flowage way between Sandusky Bay and Lake Erie had been increased. Consequently, the U. S. Army Engineers, under whose jurisdiction such matters fall, approved the request by the railroad to close permanently with rock fill the gap crossed by Bridge 65.

In view of the experience gained in battling with seepage water in the cylinders of the first three structures, the design of Bridge 64 specified conventional concrete piers to be founded on rock and constructed in a cofferdam. The decision of the engineers to do so was influenced by the fact that exploratory core borings had foretold greater troubles in the new location because of the lower elevation of the rock surface and the higher percentage of seams that might carry water. Bridge 64 has two concrete abutments—the one at the western end extending down to limestone and the eastern one resting on concrete piling—and five concrete piers. The latter are approximately 35 feet long, measured transversely to the center line of the structure, and 6 feet wide at the top. The dimensions at the base are larger by reason of the outward batter of the sides.

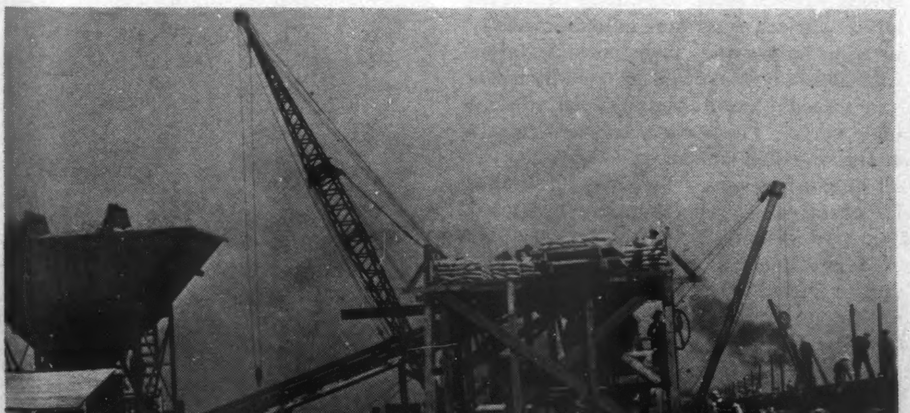
The cofferdam work was done in two stages: First the west abutment and the three adjacent piers were enclosed and constructed; then the coffer was removed and rebuilt to surround the two remaining piers. The steel sheet piling used was of "Z" section and weighed 38 pounds per square foot of wall. It was driven to rock, and because of the depth to which it extended, sometimes as much as 35 feet below water level, heavy bracing was needed to withstand external pressure. Obtainment of bracing material was no small problem. Steel could not be purchased because of wartime restrictions, and lumber was scarce. A supply of piles from 60 to 80 feet long was available, and these were put to use as transverse struts, reaching from side to side of the sheet-piling walls. Securely cross-braced, these round members served satisfactorily and made it possible to utilize the limited stock of square timbers on hand as longitudinal walers.

The cofferdam had a width of 60 feet. While this was considerably more than the length of the piers warranted, it was decided upon so that secondary coffers could be constructed inside of it. These were driven at each pier location after the water in the main cofferdam had been pumped down to the mud line. Conventional arch-web steel sheet piling was used, and the size of each coffer was the same as that of the bottom of the concrete pier.

As soon as excavating had been completed and the rock bottom had been cleaned, a concrete base several feet thick was poured in each secondary cofferdam. When set, forms were built and the remainder of the pier was poured in one lift. Concrete was piped to the point of deposit from a Pumpcrete machine stationed near the west abutment, a maximum distance of 350 feet. It was hauled to the pump in truck mixers from a batching plant installed near a siding in Danbury, approximately half a mile away. The operations involved in setting the steel deck differed little from those already described in connection with Bridges 66, 67, and 68.

Responsibility for the design and construction of the Sandusky Bay bridges originated in the office of F. J. Jerome, chief engineer, New York Central Railroad, Chicago, Ill. G. T. Donahue was district engineer, and A. M. Westenhoff was assistant engineer of structures for the railroad. W. A. Bogert was resident engineer for the railroad. The bridges were built by the Walsh Construction Company of Davenport, Iowa, as general contractor. Frank Mosher was general superintendent for the Walsh organization. The removal of the old swing bridge and the building of the bascule lift span were parts of the Walsh contract but were sublet, respectively, to the Ferro Construction Company of Chicago and the Bethlehem Steel Company, Bethlehem, Pa.

The War Department specifies that a channel at least 10 feet deep must be maintained at the bridge opening for the passage of boats. Owing to the scouring action of the lake currents, the waterway at that point was deeper than that at the time of the construction work. Comparatively few vessels make use of the passageway, and most of those are pleasure craft.



FLOATING CONCRETE PLANT

Aggregates from the bins at the left were conveyed by belt to the mixer at the right end and the concrete was pumped through a pipe line to pouring locations underneath the bridge. This arrangement made it possible to continue placing concrete during the passage of trains, and each of the three cylinders in a pier or an abutment was poured in one lift. The scow was tied up alongside the shore while receiving its supplies and then towed to the working site.

All U. S. Navy Photos

Acoustic Mines Fired by Pneumatic-Tool Beats

R. G. Skerrett

THE pneumatic riveter and the air-driven chipping hammer, decidedly audible tools, have done their full measure of construction and repair work in recent years in keeping our fighting and mercantile fleets equal to the demands laid upon them. But it may surprise many people to learn how these selfsame tools have been employed to rid navigable waters of certain sinister submarine mines secretly planted there by an enemy. The fact is that the audible "beat" transmitted by these tools through the water has been skillfully adapted to operate at a safe distance the detonating mechanisms of hostile acoustic, subaqueous mines.

The acoustic mine marks the high tide of the joint efforts of scientists and engineers engaged in developing this field of naval warfare because that weapon has a scope far beyond the older mines that had to be hit by a hapless ship unaware of their exact location. Without this actual contact, which was needed to set the mine off, a vessel could pass unhurt very close to the hidden menace. Actual contact is not necessary today to detonate the newest type of submarine mine, and a craft can be sent to the bottom or be gravely damaged when there is a considerable interval between it and the neighboring mine.

Before World War II, mines were designed to be planted and anchored in certain defensive waters either to protect harbor entrances against penetration by enemy surface ships or submarines. Still larger offshore areas were mined especially to keep submarines from coastal waters that had to be traversed by friendly naval and merchant craft making use of strategic ports. Those weapons were mostly of the so-called contact type that was set off only when struck by a floating body. Its effectiveness was therefore restricted —it was essentially defensive.

Magnetic mines were introduced late during World War I and represented a radical departure because physical contact was not needed to cause them to explode. Initially devised by the Germans, they were designed to be acted upon by the vertical magnetic field of an approaching steel vessel. They proved to be extremely destructive until research on the part of the Allies resulted in the discovery and application of counter measures that neutralized the magnetism of a craft to such an extent that its normal field would not energize the control mechanism of the mine. The methods of combatting it were more or less crude, and the war ended before the refinements of the "degaussing" process became standardized. Many advances were made subsequently. But that is another story, as is the work that was done by some of Germany's former an-

CLEARING THE SEA LANES

Destroyers engaged in sweeping Pacific waters in advance of one of our large cruisers are pictured at the top. The other view shows the explosion of a Japanese moored mine off Sasebo, Japan, as it was caught in the sweeping gear of one of our minesweepers. The Navy described the minesweeping operations off Okinawa, Japan, and the China Coast as the biggest in history.

tagonists in improving the magnetic mine.

The Germans took the initiative in introducing the acoustic mine in World War II, and also showed much ingenuity in adapting the weapon to aggressive warfare by making it possible to plant them from aircraft, submarines, and surface vessels peculiarly suited because of their speed and small size for operating after nightfall or in thick weather. The mines could thus be placed well within waters otherwise defended by mine fields, booms, and nets. As a consequence, harbors and inland waterways, supposedly secure from such attack, became targets of acoustic mines dropped under cover of darkness.

The question was how to carry out "sweeping" operations with the least possible hazard so as to rid areas of this new menace. Manifestly, the cure had to be homeopathic in its nature—that is, controlled—and sound-producing remedies had to be developed that would cause acoustic mines to explode at a safe distance from a minesweeper. In short, the latter had to be equipped with apparatus capable of broadcasting through the water sound waves that would actuate at will the detonating mechanism of such mines within the effective range of those propagated waves or vibrations.

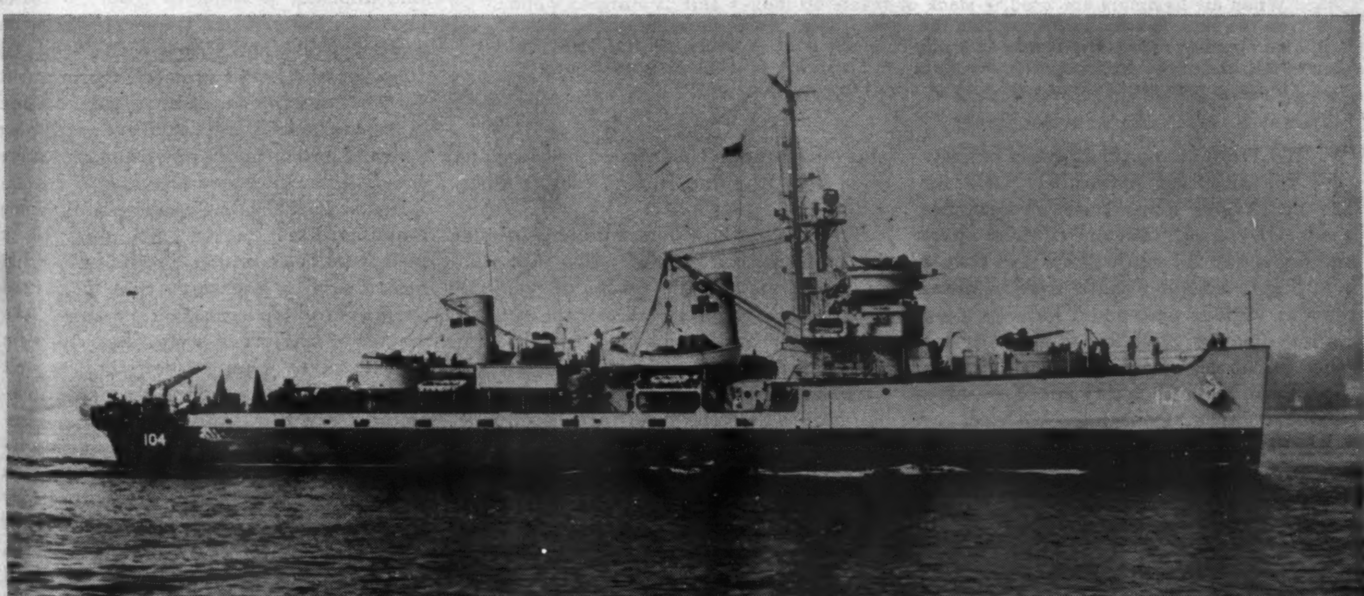
What was the antidote for enemy acoustic mines? That was the problem that faced some of our Allies, for the Germans had every reason for rejoicing over the effectiveness of their initial weapons of this type. The British, for a while, were the outstanding sufferers, and might have continued to be had not chance placed two of those mines within reach in shallow water. Grim necessity urged two specialists to disarm and to beach them despite the imminent peril involved. Deliberately, they dismantled the mines and exposed the actuating mechanisms. The next step was to discover what was relied upon to close the electric circuit which fired a booster charge which, in turn, set off the much larger and tremendously powerful mass of high explosive. This is where research and carefully planned experiments led to the unraveling of the puzzle that, in the end, revealed not only the secret of the German magnetic mine but also how it could be effectually combatted and how even better mines could be developed by the Allies.

The acoustic mine was designed by the Germans to be fired by the propeller beats of an approaching ship. These are far more audible underwater than above the surface, and the crux of the matter was to discover just what characteristic of the transmitted sound waves served to initiate the action of the detonating mechanisms. This was the key to success, because it was plain to the investigators that just any sound wave would not do the trick. They were convinced that the pulsating frequency of the transmitted sound waves was depended upon to actuate a vibrating metallic tongue or balance sensitive only to the same frequency range and so close the electric firing circuit. Protracted experiments with power-driven vessels of different kinds and sizes, together with painstaking analyses, gave the sought-for answer.

The technicists found that well-nigh all the ships had propeller beats or some vibrating frequencies that were common to them, and they rightfully concluded that the Germans had set the receivers of their acoustic mines to those frequencies. Therefore, they went ahead developing a counter measure in the form of a "hammer-box" that was planned to work on the basis of the common frequencies mentioned.

The hammer-box is a sort of metal drum within which, in the case of some minesweepers, is housed a pneumatic hammer that strikes a sound disk vigorous blows capable of transmitting radiating waves of the desired frequency and loudness for considerable distances. And it is possible to model the projecting end of the hammer-box so that the sound vibrations can be directed and emphasized within a chosen arc. The box may be hung at the bow from the outer end of a boom that can be swung from side to side and lowered so that the box can be moved through a wide arc in the water as the craft advances. In this manner the sweeper can advance at a satisfactory speed and cause the detonation at a safe distance ahead of any acoustic mines lying within the areas traversed by the sound waves produced by the pneumatic tool—be it a riveter or a chipping hammer. The rapidity or the frequency of the blows can be varied to some extent just by changing the feed of the compressed air.

The story of the modern submarine mine is a manysided one and a fascinating example of how human ingenuity and engineering skill can combine to make war grimmer and increasingly more certain in its destructiveness, but there is not space here for its telling. But at least we now know how some pneumatic tools intended for construction work were adapted to protect ships from the destructive menace of acoustic mines.

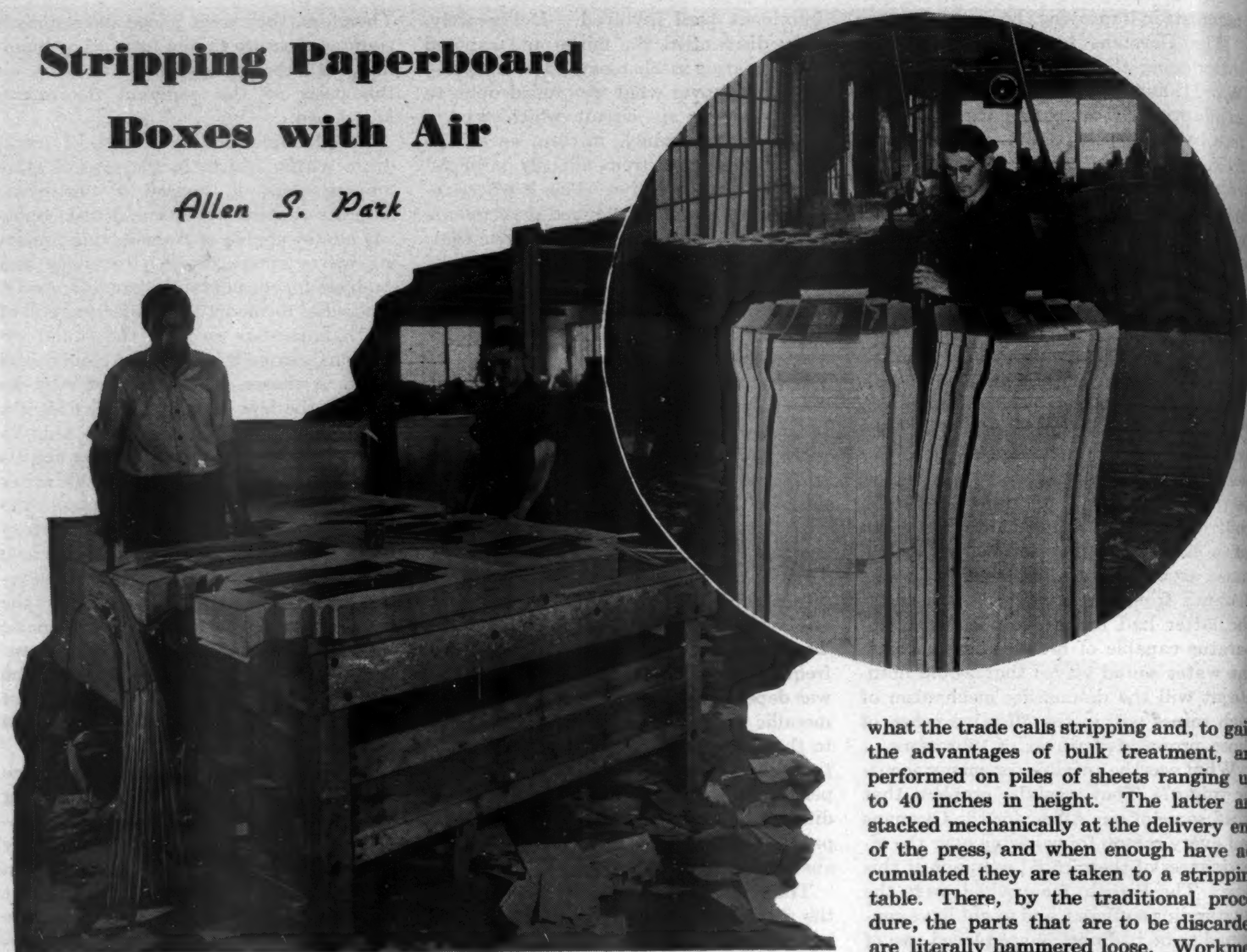


U. S. NAVY MINESWEEPER

A unit of the largest type assigned to minesweeping service. The jobs carried out by these vessels were almost always hazardous. The craft were equipped with every conceivable device for outwitting the enemy.

Stripping Paperboard Boxes with Air

Allen S. Park



OLD AND NEW METHODS

In hand stripping (above), from 20 to 40 sheets are placed on a table and the sections to be removed are broken loose by striking them with wooden mallets. When air hammers are used, a stack of sheets 40 inches high is stripped while on the skid on which it came from the press. The view at the upper-right shows an operator separating blanks in a pile of sheets each of which provides material for two boxes. In this particular plant, and working on 2-blank sheets such as these, a man strips around 46 tons of boxes in an 8-hour day.

FOLDING paperboard boxes of varying sizes are extensively used for packaging many types of consumer goods. If you will take one of them apart and lay it out flat you will observe that it is of highly irregular shape with indentations at various places and perhaps even cutouts for the insertion of flaps or for other purposes. Certain boxes, such as those in which your bakery packages some of its products, even have appendages that serve as handles to facilitate carrying. You will also notice that the material was precreased along the lines where it was folded to form the box.

Boxes of this kind are made from flat sheets, the thickness of which generally increases with the size of the container. The first of the several manufacturing steps involved usually consists in printing upon the sheet for identification the contents of the potential boxes and their vendor. Dies next outline the pattern required for a container of prescribed form and also impress the crease lines to guide and assist the subsequent folding operation.

This die work is done on conventional flat-bed printing presses. The dies that delineate the outside limits of the box blank and any interior areas that are to be removed are knives that cut through the sheet except at points where they are purposely notched so as to leave enough material to hold the sheet together during its removal from the press. The creases are put in by blunter-edged knives that do not leave a deep impression. To speed up production, multiple blanks are made from one sheet, the number obtainable depending upon the size of the box pattern because the dimensions of the sheet are limited by the size of the press.

Before the several blanks in each sheet can be converted into boxes they must be separated and the surplus material removed from edges and, possibly, from cutout areas. These operations constitute what the trade calls stripping and, to gain the advantages of bulk treatment, are performed on piles of sheets ranging up to 40 inches in height. The latter are stacked mechanically at the delivery end of the press, and when enough have accumulated they are taken to a stripping table. There, by the traditional procedure, the parts that are to be discarded are literally hammered loose. Workmen wielding wooden mallets pound the loosely adhering outer sections to break them off. To separate the different blanks from one another, a stack of from 20 to 40 sheets is taken from the pile, placed on another table, and struck with the mallet to sever the small connecting links left by the notches in the cutting knives.

As can readily be visualized, stripping by hand is an arduous operation, but there was little incentive to attempt to mechanize it so long as labor was plentiful. Some manufacturers placed stripping on a piecework basis, which kept its cost within reason and at the same time permitted strippers to earn a satisfactory wage. As a matter of fact, there were times during a year in many plants when there wasn't sufficient work to keep the normal complement of strippers fully employed. Consequently, and also because the outlay involved represented but a small proportion of the total manufacturing cost, it is easy to understand why stripping was more or less neglected and forgotten and why the industry, with few exceptions, devoted little study to ways of improving it.

This policy was, of necessity, changed when the war brought on a labor shortage that was generally felt but was more acute in some sections than in others. In many plants, stripping began to fall behind other operations, and unstripped material rang-

DIFFERENT TYPES OF WORK

The operator at the upper-left is removing outside trim from sheets each of which provides three box blanks. The girls at the upper-right are separating blanks in a stack of 27x35-inch sheets made up into 25 box blanks. Where some interior sections must be stripped from small blanks the latter are often placed in jigs, as shown at the bottom. The table revolves, enabling the operator to remain at her station. One of her helpers keeps the table supplied with blanks while the other takes each stack after it has been stripped and puts it on a skid. In this case the stripper is removing what are known as Arthur locks.

ing from 150 to 500 skids accumulated. Various expedients were tried to overcome this bottleneck. Workers were temporarily transferred from other duties, high-premium rates for overtime were instituted, high-school students and other part-time workers were employed, and in some instances executives became strippers over week ends. Still, little real headway was made, and the situation became so serious that something had to be done to meet it.

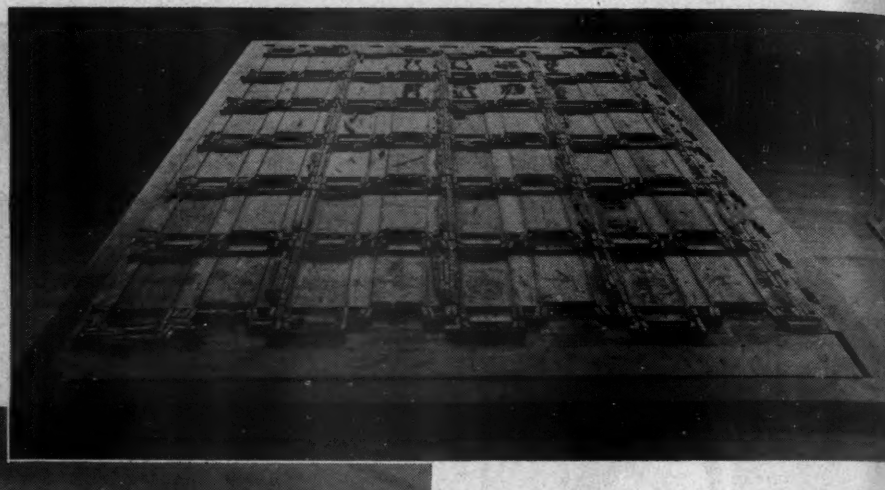
Here was a simple operation requiring little skill and not much equipment, yet it was slowing down the whole production cycle. Management decided that it warranted careful study and delegated the task to a committee of five members of the Folding Paper Box Association of America. One of the first conclusions reached was that the problem concerned the management and engineering groups of the industry as much as it did labor. H. W. Schwartz, a member of the committee who visited various plants in the eastern part of the country under the sponsorship of the association, stated in a progress report:

"We owe it to labor and to our industry to devote sufficient study to this operation with the objective in mind of eliminating a large part of the physical exertion and fatigue that is involved in this work. We must make the work more attractive to newcomers by eliminating the sheer brute strength which was formerly considered an important qualification in order to be a stripper."

Some few factories had been using air-operated hammers for stripping for several years, and it was therefore only natural that the committee should inquire as to the results of this experience. It was

DIES AND HAMMERS

The die assembly at the right is made up of cutting and creasing knives for sheets from which 24 boxes will be made. The other picture shows four sizes of Ingersoll-Rand chipping hammers that are used in stripping paperboard boxes. The biggest one is generally fitted with a 21-inch chisel for large-size blanks; the three others strip blanks of smaller dimensions. All are aircraft-type tools. From left to right they weigh: 4 pounds 14 ounces, 6 pounds 2 ounces, 6 pounds 12 ounces, and 12 pounds.



found that the pneumatic method had great inherent possibilities, but that these were not being fully realized because the work was not planned and directed so as to obtain maximum efficiency. Mr. Schwartz estimated that, on account of these conditions, the hammers were in service not more than 35 or 40 percent of the working shift.

The committee thereupon centered its investigations on plant routine with the aim of revamping it and coördinating the various operations so as to use the hammers more effectively. These studies were pursued for more than a year and have led to the introduction of procedures by which pneumatic hammers can be employed with favorable results. Various changes in established plant practices were found to be desirable to facilitate the use of air tools. These start in the layout department, where minor revisions in box design and cutting dies may simplify the stripping operation. When a new type of box is to be produced, a test skid is usually stripped, and this often reveals where die changes can be made that will aid the stripper.

For successful pneumatic stripping it is essential that the sheets be stacked with greater accuracy than is possible with the jogging mechanism at the delivery end of the press, and for that reason it is customary to employ a girl for that service. Unless the stacks have perfectly even sides, stripping will be difficult and there will be spoilage. Air-hammer stripping is done on the skids on which the blanks are delivered from the press, thereby obviating their removal to tables. It has been determined that the most convenient and most comfortable height of stack for the operator is about 40 inches.

The tools used are conventional chipping hammers run by compressed air at 80 to 100 pounds pressure. For the usual class of work, a chisel 21 inches long has been found to be most suitable. It has a flat, curved tip which is placed on the line made by the cutting knife and with the curve always pointing away from the blank. When power is applied to the hammer, the chisel quickly works down through the pile, cleaving the border sections loose and causing the waste material to fall away like a toppling deck of cards. The weight of the tool is sufficient to carry it downward, the operator only has to guide it. The same equipment serves to separate the various blanks in a sheet. For smaller blanks, smaller hammers and shorter chisels are employed, and the stacks of blanks are commonly held in jigs and fixtures. These are mounted on revolving stands, enabling the operator to remain at the same station. With the lightweight equipment involved, girls can do the stripping. By the old hand method, and when air tools were first tried out, the stripper usually helped to dispose of the scrap. Now it is swept away as fast as it accumulates by workmen assigned to that duty, and the stripper loses no time from his job.

With regard to the over-all results achieved with the pneumatic-hammer technique, a report of the committee in charge of the development states: "It has been definitely established that the use of air hammers has appreciably reduced the physical exertion and fatigue formerly required for this work and it thus makes the work more attractive to labor. The studies indicate that one air-hammer operator, with the proper auxiliary help, can handle anywhere from three to ten times the quantity of boxes per hour that one hand stripper can produce.

"It should be noted that these results can be attained by operators having less skill than that required by an experienced hand hammer stripper, and, in some types of jobs, without the necessity of lifting or moving a single blank. The reduction of physical exertion and fatigue, with the resultant building up of morale in the department, is, in itself, a tremendous advantage as it makes the work in the stripping department much more attractive to labor than hand hammering. It also permits the use of females who do not have the physical capacity or endurance which the normal hand hammer operation requires. The gain in production as a result of the adoption of air hammers will vary with the type of work and with the thoroughness of the planning."

There are many benefits incident to the new method. Greater speed makes it possible for the stripping department to keep abreast of the cutting and creasing department. Consequently, there is no backlog of unstripped material, and the floor space formerly required can be greatly reduced. It follows that there is less plant congestion. Moreover, air hammers are reported to turn out cleaner work with less spoilage, to reduce the amount of dust created, and to keep the boxes flowing steadily through the gluing department and on to customers.

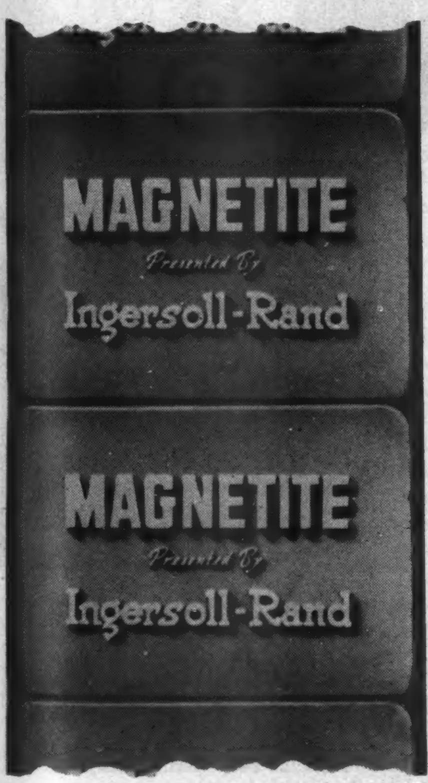
The cost of the air equipment required will obviously vary with the size of the plant. For an establishment that strips from 1000 to 1500 tons of board per month, it has been found that an air compressor and the necessary piping and tools can usually be provided for not more than $3000.

Movies Show Mining and Tunneling Operations

INDUSTRIAL motion pictures are continually gaining in popularity, and manufacturers now recognize them to be one of the most effective publicity mediums at their disposal. The average person enjoys a movie, provided it is well planned and produced and has a story of interest to tell. Early industrial films had many shortcomings. They lacked a lot from a technical standpoint and, furthermore, were filled with advertising propaganda.

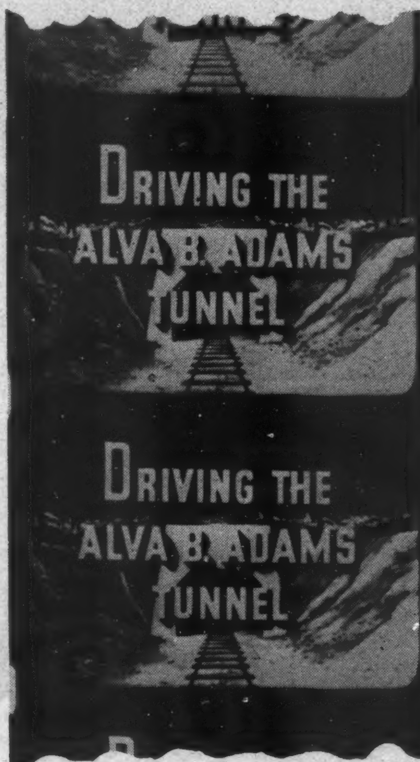
Today's industrial movies show great improvement on both counts. There are many capable producers in the nation now, and they are acquiring some of the know-how that has made Hollywood camera artistry a box-office drawing card. Animated drawings are used with good effect to amplify and explain the on-location shots, and other Hollywood artifices and dodges have been borrowed and adapted to the purpose at hand. Color and sound have been added to lend their obvious advantages. Along with better craftsmanship has come increased ingenuity in script writing and story structure. Manufacturers have learned to subdue emphasis on product in the interest of presenting a picture that smacks more of entertainment than advertising.

Three new industrial motion pictures that combine education, instruction, and entertainment are available for free showing upon request to the Film Bureau of Ingersoll-Rand Company, Phillipsburg, N. J. They are of especial interest to mining and heavy-construction men, as well as to engineering organizations, but are sufficiently general in scope and treatment to appeal to lay audiences ranging from college and high-school classes to service clubs and civic societies.



All these movies have to do with the excavation of rock or ore and depict modern mechanical methods that are continually increasing the efficiency of the operations involved and at the same time making the lot of the workers easier. All three are 16-millimeter, Kodachrome productions, with sound. Following, are brief descriptions of them:

"Blackjack," projection time 22 minutes. The title is the name given by miners to the black zinc-sulphide ore (zincblende or sphalerite) that is mined in the Tri-State District centering around Joplin, Mo. Nearly a billion tons of zinc and lead ore has been produced there. The general story of the underground operations is portrayed, with emphasis on the use of hoist-powered scrapers for moving and loading the broken material. Maps, wash drawings, and other animation devices serve to show the three principal types of ore bodies and the mining systems by which they are worked.



"Magnetite," projection time 31 minutes. This film describes the mining and milling of magnetite iron ore at the properties of the Republic Steel Company in the Adirondack Mountains of New York. Various mining systems are explained by the aid of animated artwork and its accompanying narration. Here, also, scrapers powered by air or electric hoists are of importance in handling the ore and rock. Special attention is given to them, as well as to the functioning of rock drills and other essential tools and machines. Reconditioning of the drilling elements—Jackbits—and of the drills themselves is pictured in one of the nation's most modern mine shops. Because of its diversity, the film is of interest to general audiences as well as to men identified with the mining industry.

"Alva B. Adams Tunnel," running time 20 minutes. This film shows the driving of a 13-mile tunnel through the Continental Divide in Colorado to permit the diversion of irrigating water from the western slope to the plains on the eastern side of the range where a goodly share of the nation's sugar beets is raised. It is the key feature of the Colorado-Big Thompson Project of the Bureau of Reclamation that will bring additional water to 610,000 acres of farmland and generate electric power as a by-product of that service. Details of the tunneling procedure are seen more clearly on the screen than they could have been on the job itself. The picture is a revision of one released two years ago. Animated drawings have been added to explain how the project will function, and footage driven later has been incorporated to depict the holing through when the workers from the two portals met five miles from daylight. This is the longest tunnel ever advanced from only two points of access. The film is designed to interest both nontechnical and technical audiences.

Midget Life Saver

Photos from "Dravo Slant"

IN AND OUT—UNHARMED

William Plotner, a deckhand on the "Sam Craig" of the Union Barge Line, takes a ducking to accommodate the photographer. The picture of the hand shows one of the tiny cartridges of compressed carbon-dioxide gas that inflate the life belt, making it impossible for the wearer to sink.

THE carbon-dioxide life belt that was effectively used by our armed forces is now being applied to safeguarding civilian workers around water. An employee of the Union Barge Line, an affiliate of Dravo Corporation, Pittsburgh, Pa., posed for the accompanying pictures to demonstrate how the belt serves to keep afloat an individual who has accidentally plunged into the water.

The practice of protecting workers against possible drowning was adopted by some organizations about fifteen years ago. One of its first applications was during the building of the San Francisco Bay Bridge. Bulky kapok-filled vests were put on, and, while they accomplished their purpose, they impeded the movements of the wearers. Nevertheless, their virtues were such that the Dravo Corporation made them standard equipment in its contracting division, and soon extended their use to other corporate divisions.

Now the midget cylinders of compressed gas make it possible to use lighter, more comfortable belts. When a worker falls overboard, he merely presses one side of his belt, thus puncturing two gas containers. Almost instantly the gas flows out, inflates the belt, and the wearer is insured against sinking until he can get out of the water. If the belt loses some of its gas for any reason it can be inflated by blowing air in with the mouth.

Charles Frank Schwep

CHARLES FRANK SCHWEP, who had completed almost 53 years of service to the compressed-air industry, died suddenly on April 17 at his home in Plainfield, N. J. He had spent the previous day as usual in his office in New York, where he was a vice-president and director of purchases of Ingersoll-Rand Company.

Mr. Schwep was born on May 5, 1872, in Easton, Pa., and, after attending public school there, entered the employ of the Lehigh Valley Railroad. During the next three years he worked in the machine shop, engineering department, and finally as purchasing agent. Meanwhile, he studied engineering and metallurgy at night.

On May 1, 1893, he started to work in New York for the Ingersoll-Sergeant Drill Company, one of the predecessor firms of Ingersoll-Rand Company. A year later the concern occupied a new factory it had erected in Easton and Mr. Schwep returned to his native city. He became, successively, head of the order department and purchasing agent and was transferred in 1904 to a new plant that was opened in Phillipsburg, N. J.

In 1905, when his company and the Rand Drill Company were merged to form Ingersoll-Rand Company, Mr. Schwep was made general purchasing agent, with headquarters in New York. From that time on he had jurisdiction over the company's purchases for its three manufacturing plants in this country, and in 1929 he was given the title of vice-president and director of purchases.

As an avocation, Mr. Schwep engaged in oil painting, specializing in industrial scenes. Many of his pictures hang in the offices of his business associates and friends, and the walls of his home studio are covered with them. One of his foundry paintings was reproduced in color in our June, 1936, issue and another one appeared last September.

In addition to his company affiliation, Mr. Schwep was active in the affairs of his home community. He was one of the organizers of the Mid-City Trust Company of Plainfield and served continuously as chairman of its board of directors until his death. He was a director of the Plainfield Title & Mortgage Guarantee Company and of the Plainfield Building & Loan Association. During the recent war he was chairman of one of the rationing boards in his city, and he formerly served as chairman of the North Plainfield Board of Education.

Mr. Schwep was senior warden of the Holy Cross Episcopal Church of Plainfield. He was a member of the Railroad Club in New York and of the Plainfield Country Club, and since 1918 had been active in the affairs of the National Association of Purchasing Agents.

Self-Sufficient Burrows for Humans

IT IS no longer a secret that there are three underground "cities" within the confines of London. They were built in 1940, during the stage of the war when it was most critical for Britain, as shelters for her executives. Like any modern community, they are equipped to provide all essential services, plus others of a special nature, to make them habitable. The largest of them, generally known as the Horseferry Road Citadel, can house and provide for the needs of about 2000 persons for at least three weeks under the worst possible conditions, not excepting poison-gas attack.

Aside from stores of fuel and food, the nucleus of each of these burrows is the power plant which, in the case of the Citadel, consists of four diesel engine-generator sets. Each of these is made up of a 2-stroke oil engine with a capacity of 375 bhp. at 500 rpm. and of a direct-connected 250-kw. generator. The units are installed 50 feet below ground level in a space approximately 35 feet long and 20 feet wide. At one end, in a separate chamber, are two coolers through which the engine water is circulated to lower its temperature by air induced by motor-driven fans. The exhaust gases from the engines are passed through Burgess silencers that are well insulated to prevent the room from becoming excessively hot. Fuel-oil tanks holding 25,000 gallons are located on the same floor.

Starting air for the engines is stored in receivers at 350 pounds pressure per square inch and furnished by one or other of two small compressors. One of the units is motor-driven, and is used under conditions when it is not possible to take current from the surface network; the other is a gasoline-engine machine which serves when energy from that source is not available.

In case of an emergency, the power station can, within a few minutes, take over the job of generating electricity for lighting and cooking, for pumping water, sewage disposal, refrigeration, air conditioning, ventilation, and for auxiliary services. With the Citadel fully occupied and all facilities in use, it is estimated that the peak load will not exceed two-thirds of the plant's total capacity.

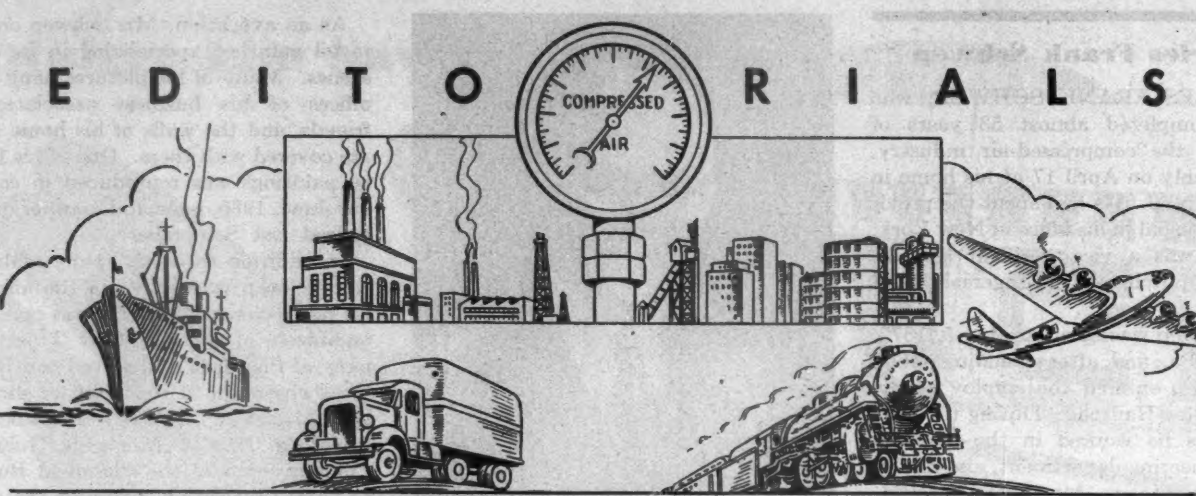
An artesian well sunk through the foundation of the underground shelter supplies water for all purposes, and pneumatic ejectors, using air at a maximum pressure of 30 pounds, empty settling basins of sewage for pumping into London's disposal system. Pumps are also required to handle seepage, which posed something of an engineering problem because of the marshy nature of the site. To keep the various rooms dry, the Citadel has been built with double walls, and any water penetrating the outer one is pumped from the intervening space into the service mains. Hot water for general use is provided by two coal-fired steam boilers designed for a working pressure of 80 pounds per square inch, and three 175-hp. CO_2 compressors meet refrigeration needs.

The only thing from the outside indispensable to the troglodytes is air, and this is taken in through a central duct and passed through a washing and filtering plant. Under maximum conditions, approximately 100,000 cfm. is required, or enough to change the air completely four times an hour. In the event of a gas attack, a damper at the bottom of the main air intake is electrically operated by remote control, thus causing the air to flow through gas filters and setting a fan in motion to exhaust the gas until the danger of contamination is past. To prevent gas from leaking through the walls of the shelter, the ventilating air is maintained at a pressure just slightly above that of the atmosphere. Experience has proved that a temperature of 68°F. and a relative humidity of 55-60° meet all requirements.

Within plain view of the shift engineer's office is a 9-panel switchboard with a system of audible and visible warning signals, and this enables him to have complete control of the engine-generator sets and of all the service needs in every part of the underground city.

The Citadel, owing to the course of the war, was never put to maximum emergency use, but it did serve to house government departments. Under those circumstances the necessary power was taken from above ground and the diesel-engine generators were operated only a few hours daily during peak-load periods in the winter months.

EDITORIALS



MISSOURI RIVER PLAN

A DEVELOPMENT program that will affect one-sixth the area of the nation was launched on May 15, when ground was broken for the construction of Kortes Dam and Power Plant on the North Platte River 60 miles southwest of Casper, Wyo. The ceremony marked the beginning of work on the Missouri Basin Plan, which calls for the development of the land, water, mineral, and hydroelectric power resources of the 1300-mile-long Missouri River Valley. The over-all project, which was approved by the Congress in 1944, envisages the expenditure of two billion dollars.

In the course of the work, more than 100 dams will be erected on the Missouri and its tributaries, and they will impound more water than flows out of the mouth of the river in an entire year. From the reservoirs thus created, water will be released as it is needed to irrigate farmlands, produce power, and maintain navigation. Approximately 150 irrigation systems, embracing thousands of miles of canals and other facilities, will carry portions of the stored water to semiarid farmlands. Some will be diverted to supply at least nineteen communities. More than twenty power plants, with auxiliary structures, and thousands of miles of transmission lines will generate and distribute low-cost electric energy. Hundreds of miles of levees and dikes will be built to control floods, and approximately 760 miles of the main waterway will be channeled to a uniform depth to promote navigation.

The irrigation facilities are expected to bring into production 53,000 new farms aggregating 4,760,000 acres. When fully developed, they will support a rural population of 212,000 persons. Additional water will be delivered to 547,000 acres where the present supply for irrigation is insufficient. The yield from these, based on prewar prices, will be increased by an estimated $175,000,000 annually.

When all the power plants are in operation, they will generate 5½ billion kilowatt-hours of current annually, of which about 4½ billion will be available for industrial and commercial use. The sale of the power is expected to produce an average annual revenue of $21,800,000.

The dams and levees will curb the floods that have periodically devastated farm and urban areas in the lower valley despite huge expenditures for control measures. During the first four years of the 1940's alone, the river destroyed $149,000,000 worth of property. Regulation of the Missouri's flow is also expected to help relieve the flood menace in the Mississippi.

Water released from upstream dams during periods of low river flow will maintain a navigable stream depth for shallow barges between the mouth of the river, near St. Louis, Mo., and the head of navigation above Sioux City, Iowa, a stretch of more than 700 miles. Reservoirs in the lower Missouri Basin will similarly benefit navigation on the Mississippi.

The municipalities that will receive domestic water supplies through the development are in the upper basin. This water will be withdrawn from the Cheyenne River and the Red River of the North. Among the larger communities that will benefit are Fargo and Grand Forks, N. D., and Moorehead and East Grand Forks, Minn.

The Missouri River Basin includes all of North and South Dakota and Nebraska, almost all of Montana, more than half of Wyoming, the northwestern quarter of Colorado, the northern half of Kansas, a considerable part of Missouri, and small parts of Iowa and Minnesota. It embraces 530,000 square miles of territory—more than ten times the area of New York State. Although it and its tributaries drain a region 1300 miles long and 700 miles wide, the meandering Missouri is 2500 miles long.

Approximately seven million people live in the basin, which yields half of our bread, one-fifth of our butter, one-sixth of our pork, one-fifth of our beef, one-fourth of our mutton, and almost one-third of our wool. Even so, the lack of rainfall in its western portion has retarded its full development, and in the 1930's the drought-stricken areas produced a "dust-bowl" that wiped out large investments, deprived thousands of families of a means of livelihood, and cost American taxpayers 1200 million dollars for relief. Paradoxically, during periods of high water, the rampaging stream piled up an average annual flood damage of 18½ million dollars.

The Missouri River Basin Plan will be carried out jointly by the United States Bureau of Reclamation and the Corps of Engineers of the United States Army. The former will work downstream from the headwaters and will be concerned principally with the creation of works for irrigation, power generation, and the development of land and other resources. The Army Engineers will work upstream from the mouth of the river and will rear structures designed primarily for controlling floods and improving navigation.

Thus far, the Bureau of Reclamation has been authorized by the Congress to begin work on 29 units in the project which will be inaugurated as funds are appropriated. Its immediate program calls for three specific undertakings for which funds have been made available. In addition to Kortes Dam and Power Plant, these are the Angostura irrigation scheme on the Cheyenne River in western South Dakota, and the Boysen Dam and Power Plant on the Big Horn River in northwestern Wyoming. Meanwhile, the Army Engineers have started work on some of the lower river units in the plan. The only large dam on the Missouri River system at present is the Fort Peck structure in Montana, which was built by the Army Engineers in the mid-1930's as an aid to navigation. All told, however, there are 1342 water-storage reservoirs in the river network.

The Kortes Dam and Power Plant will be located in a rocky canyon about two miles downstream from the Seminoe Dam, which the Bureau of Reclamation completed in 1938 to provide irrigation water for 66,000 acres of land on the Kendrick Project. The chief purpose of the Kortes development will be to relieve a threatened power shortage in the area. Much of the 36,000 kilowatts of energy it will provide will be used to develop coal, oil, and other mineral resources.

Industrial Notes

To facilitate the installation of its Hydent (indent-type) connectors on small electric wire and cable, Burndy Engineering Company, Inc., has developed a special pneumatic press called the Hypress. The device is bench-mounted and is designed to indent the connector onto the wire and to close the insulation grip with one quick, foot-controlled stroke. The die sets are tilted slightly so operator can see that the work is properly placed. Dies are interchangeable, and one pair accommodates three connector sizes. Those now available will take Nos. 18, 14, and 10, which means that connections may be made on wire and cable sizes from No. 22 to 10, inclusive.

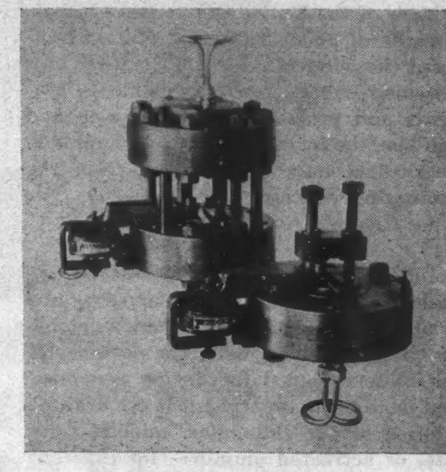
Germany is reported to have developed a satisfactory substitute for mica. The material is composed of several layers of glass fabric impregnated with a mixture of resinol, alcohol, and osmokaolin and bonded under heat and pressure. It was used for insulating commutator segments of motors and generators.

A cage with a floor of solid steel 12 inches thick and carrying a compressor, rock drills, steel sharpener, and other machinery required to sink a mine shaft is being used in a foreign country, according to Robert S. Lewis, professor of mining, University of Utah. There is a 36-inch opening in the floor that provides access to the shaft bottom and serves as a passageway for the muck bucket. Fully equipped, the cage weighs 50 tons and is not jarred severely, it is claimed, during blasting, thus permitting the workers to remain on it and to start spoil removal as soon as the atmosphere has cleared.

Unloading of bottom-dump cars at the Morris Brooks and Emma mines of the Nevada Tungsten Company, Kimberly, Nev., is facilitated by the use at the ore pockets of corrugated rails to jar the cars. The locomotive travels on a paralleling track of smooth rails.

For industrial emergency treatment of the victims of shock or other injury, Mine Safety Appliances Company is offering a source of dry heat of convenient size for first-aid kits, cabinets, etc. Called the Redi-Heat Block it is said to reach maximum temperature in one minute and, wrapped in a towel or blanket, to provide heat for about one hour. It is essentially a block of lightweight metal with high heat-transfer value that is encased in a special cover and contains a replaceable sealed metal cylinder charged with a new chemical compound. The latter is activated by releasing a spring-loaded lever.

Stainless W, an alloy of the 18-8 type patented by the Carnegie-Illinois Steel Corporation, is now available in specified shapes and sizes for industrial use. Its most important element is titanium, which is the principal precipitation-hardening element and also a strong ferrite former. Aluminum is added as a deoxidizer in melting, and the excess that remains in solid solution serves to augment the hardening action of the titanium. Additional alloying elements are nickel, manganese, chromium, and silicon. Hardness in annealed condition is 20/28 Rockwell C, with maximum tensile strength of 150,000 pounds per square inch and yield strength of 115,000 pounds. By correct treatment it can be raised to 39/47 Rockwell C, with tensile and yield strengths up to 225,000 and 210,000 pounds, respectively. The steel can be rolled into billets, bars, sheets, and shapes, drawn into wire, pierced for tubing, and forged to shape and size.



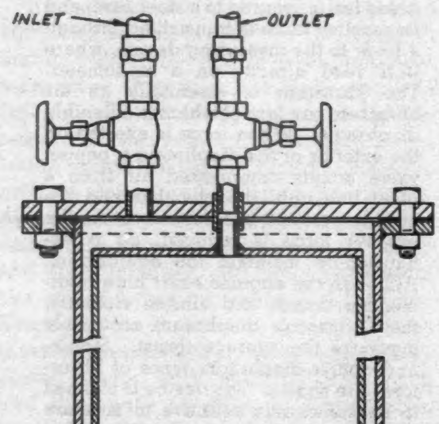
TESTING POWER OF BUZZ BOMBS

In measuring the thrust of jet engines by which buzz bombs are propelled, technicians at Wright Field, Dayton, Ohio, are utilizing a device that makes use of compressed air. This is the Thrustorq produced by Hagan Corporation of Pittsburgh, Pa. The engine undergoing test is secured to a steel base, and its reactive force is transmitted through a lever to the measuring device, where it is read directly on a manometer. The Thrustorq is essentially an air chamber, one face of which is a flexible diaphragm. When force is exerted on the exterior of the diaphragm a poppet valve admits compressed air from a plant line until the chamber and the outside pressure are balanced. As the exterior force is reduced, air is exhausted to maintain the equilibrium. Although the engines exert high intermediate thrusts and vibrate violently, the Thrustorq's diaphragm accurately measures the average thrust. Single- and double-diaphragm types of Thrustorqs are shown. The device is claimed to be sufficiently sensitive to measure the force of a boy's peashooter or that of a giant jet-airplane engine.

Student Competition

IN THE interest of developing additional information on mechanical loading and related practices in hard-rock mining and tunneling operations, a prize competition is announced by The Eimco Corporation, manufacturer of "Rocker Shovels." It is open to senior and graduate students in mining engineering schools of the United States and Canada. Awards of $500, $300, and $200 are offered the winners. The information thus obtained will be made available to students and professional mining men and will later be incorporated in a handbook. Particulars may be obtained from the sponsoring concern, P.O. Box 300, Salt Lake City 8, Utah.

Entrained moisture in air lines is undesirable and is generally removed by one or other of the many separators available for that purpose. One of the newest was originally designed for drying generator acetylene gas and permits the use of three filtering media—Fiberglas, calcium chloride, or activated alumina—for different degrees of moisture removal. The unit consists of a seamless steel tube, 6 inches in outside diameter, and of a removable inner shell or cartridge of rolled sheet metal. The latter has a perforated bottom and contains the drying material. Incoming gas or air first passes downward



through the annular space, where some of the entrained moisture is trapped, and then has to travel upward the full length of the cartridge to reach the outlet valve. For economy of operation and maximum moisture removal two units may be mounted in series. The use of Fiberglas in the first drier will prolong the effectiveness of either of the chemicals, and the

need of servicing will be less frequent. The 636 Series Dryer, as it is designated, is a product of The Gasflux Company. It is also suitable for use in connection with welding and brazing where moisture conditions cause difficulties.

A magnetic extractor for the recovery of broken drill bits, drill rods, and diamond bits from drill holes has been announced by the Dings Magnetic Separator Company. The device is made of a special Alnico steel and, attached to the face of an old bit at the end of a drill rod, is inserted into the hole. It weighs only 1 pound and is said to have a vertical lifting capacity of 25 pounds, combined with unusual holding power even when in contact with small or uneven surfaces. Extractor is available in diameters of 1¼ and 1½ inches.

For industrial indoor and outdoor jobs necessitating temporary application of intense heat there is now available a new-size tablet that is said to give a flame 1 foot high. The Heatab Heatmaker, as it is named, is 1½ inches in diameter and 1 inch thick and is suitable for such jobs as preheating torches, keeping solder pots at proper temperature, annealing small parts, softening heavy wires, and building up steam pressure for working models.

According to an item in a recent issue of *Foreign Commerce Weekly*, two Swedish motor technicians have developed a means by which the moisture content of the gas mixture can be kept permanent, making cars run as well daytime as at night. The new system uses steam instead of direct injections of water to increase the amount of moisture in the mixture. Heat from the exhaust pipe serves to produce overheated steam, and this is piped through a purifier and mixed with gas as it leaves the carburetor. The device requires little space and is said to effect fuel savings of from 10 to 12 percent.

To prevent the spread of athlete's foot in change houses, the Peda-Spray Company, Inc., has recently introduced a new treatment that is claimed to be more effective and more sanitary than the tank of disinfectant ordinarily used in common by the miners. The device is simply a pressure spray set in a low, 26-inch-diameter base with a grating on top. Upon leaving a shower, the worker steps on the grating and brings pressure to bear on it with his body first on one side and then the other, thus spraying his feet with a solution that is said to kill the organism that causes the trouble. The next man that comes along repeats the operation but receives a fresh application. The equipment, known as Peda-Spray, was used during the war by the Army and the Navy. It is now generally available.

Industrial Literature

A new electronic potentiometer-pyrometer that has no continuously moving or vibrating parts in its measuring circuit is described in a 16-page bulletin, No. 232, issued by the Bailey Meter Company, 1050 Ivanhoe Road, Cleveland 10, Ohio.

To help industry make its production plans, the Journal of Commerce, 63 Park Row, New York 15, N. Y., has published a *Scarce Materials Timetable* that indicates when materials that are now in short supply may again be readily obtained. It discusses the various factors influencing the supply situation with respect to 21 basic raw materials. Copies are obtainable for 25 cents each.

Vibro-Levelers are machinery mountings that are designed to prevent the transmission of vibration and also to provide a means for leveling the machines. They are applicable both to small equipment such as bench grinders and to large machines like punch presses and drop hammers. A descriptive bulletin, No. BU50, has been issued by the manufacturer, Bushings, Inc., Coolidge and 14-Mile Road, Royal Oak, Mich.

Individual-type Dustkop collectors suitable for dirt and lint from dry-grinding, buffing, polishing, and similar machines, are described in a new catalogue, No. A-350, that can be obtained from Aget-Detroit Company, 602 First National Bank Building, Ann Arbor, Mich. The catalogue also discusses a Dustkop unit for collecting vapor from screw machines and similar machine-shop equipment using coolants.

A screw driver that can be set so that it becomes inoperative when the desired torque is reached makes it impossible to overtighten a screw, nut, or bolt. A tool of this type is made by Airdraulics Engineering, Inc., New Canaan, Conn., and is described in a catalogue data sheet that is available upon request. Known as the True-Torque, it is made in three standard sizes for different torque ranges.

As is true of all other commercial metals, copper has distinctive characteristics that affect its weldability and that determine the procedures that are recommended for welding it. Any one of several methods may be used in welding most copper alloys, the choice depending largely upon knowing the properties of the alloys and how they are affected by the different procedures. C. E. Phillips & Company, 2750 Poplar Street, Detroit 8, Mich., has produced a handbook dealing with these matters. It presents data gathered from plants where the joining of copper and copper alloys is extensively practiced. The publication, which is free, is titled *Welding and Brazing Copper and Copper Alloys.*

Jack Steele, inspector of automobile headlights for the State of California and chief of the headlight and wiring department of a Hollywood service garage, has written a little book called *How to Find a Short.* It is designed both for the skilled garage mechanic and the average car owner, being written for easy understanding. It answers such questions as what to do if your headlights suddenly go dead, if your horn starts blowing for no apparent reason, or if your battery runs down overnight. The illustrations include wiring diagrams of nearly all standard makes of cars. Fifty case histories of different types of wiring troubles are presented to show how to solve almost any disorder of this kind. The 225-page book is available from The Norman W. Henley Publishing Company, 17-19 West 45th Street, New York 19, N. Y. Price, $2.00.